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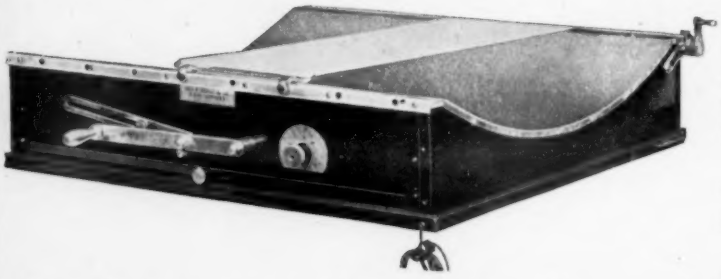

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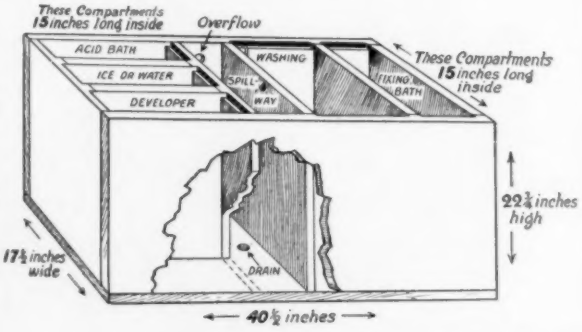

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. X MARCH, 1923 No. 3

NEW GROWTHS WITHIN THE CHEST: X-RAY DIAGNOSIS*

BY SAMUEL B. CHILDS, M.D.

DENVER, COLORADO

NEW growths within the chest present to the roentgenologist complicated problems for diagnosis. As an aid in the solution of these, it is considered necessary to review not only the changes characteristic of new growths, but also those associated with certain inflammatory conditions which may produce a similar appearance.

Growths within the chest may be divided, for the sake of description, into two classes:

1. Those in the mediastinum.
2. Those in the lungs.

Mediastinum. Hodgkin's disease is generally shown by a paratracheal, dense shadow projecting beyond the mediastinum, with a border, either irregular in outline, or circumscribed and clearly defined, which extends over a considerable part of the median shadow. These masses may attain to a large size, projecting beyond the mid-clavicular nipple line, and extend the entire length of the median shadow. Occasionally only a unilateral mass projects at the level of the hilus, circumscribed by a border similar to that above described. The diagnosis in this disease can be confirmed by biopsy.

Lymphosarcoma starts in the mediastinum and is apt to increase rapidly in size and involve the lung or pleura, or both. Illustrative of this condition, the report of the following case is of interest. I am indebted to Dr. S. G. Bonney for the patient's history.

Female, aged twenty-three, married. Previous health good until the spring of 1920. Had been losing weight and strength, but continued to be up and about until April, 1921, when she went to an eastern clinic. Had a slight fever in the afternoon. No tubercle bacilli. No positive diagnosis made. Advised to go home and rest. Had acute mastoid and recovered. Went to California on a pleasure trip; was in Los Angeles three months. Three days after arrival, became ill and been in bed ever since. Severe pain in the left chest. Pain on taking full breath. Fever daily, 100 to 102° F. Chills often, night sweats often. Cough very severe. Very slight expectoration. Cough paroxysmal. July 15th, bowels loose, very offensive mucopus. Pain. Went home to Nebraska first of September. Advised to come here. First aspiration last July, two quarts, cherry red. Second one was made week ago in Nebraska, one pint a.m. and one p.m. same day, same character. Not much improvement in breathing. Reported to Dr. Bonney Sept. 7, 1921. On that day he aspirated and drew a pint of bloody fluid. Patient referred to the writer for an *x*-ray examination Sept. 9, 1921, malignancy being suspected. Patient unable to leave bed and examination was made by portable. The result of this examination is as follows: The left lung is obscured by an extensive effusion with the fluid level surmounted by a pneumothorax in extreme apex. There is demonstrated a paratracheal mass on the right side about 3½ in. long and 1 in. wide in greatest

* Read in part at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angles, Calif., Sept. 12-16, 1922.

diameter. Heart shadow displaced to the right. No pathology shown in the right lung (Fig. 1). In the diagnosis, two conditions only were considered, sarcoma and Hodgkins. A few small glands were detected above the left clavicle, one of these was removed by Dr. Bonney and the pathologist's report was lymphosarcoma. The patient died about Sept. 20, 1921.

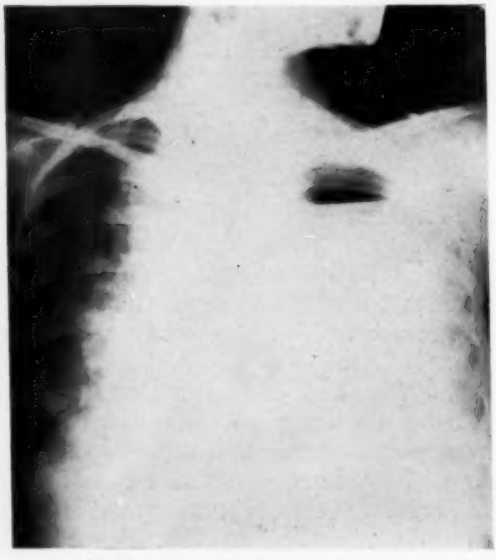

FIG. 1. Lymphosarcoma. Paratracheal mass on right side. Involvement of left lung and pleura with hemopneumothorax of left side. Diagnosis verified by biopsy. For clinical history see text.

Intrathoracic thyroid casts a fairly characteristic shadow of uniform density, in the upper part of the mediastinum. The base of this shadow is situated upward, having a lessened diameter at its lower extremity. The edges of this shadow are generally well circumscribed.

Enlarged thymus should cast a small, inverted, heart-shaped shadow which overlaps the aorta and the base of the heart.

A number of the cases in which the diagnosis of enlarged thymus has been made have not been verified by a post-mortem examination, hence a diagnosis in this condition is not considered particularly reliable.

Cysts cast characteristic shadows, generally well circumscribed and of uniform density. A dermoid cyst is characterized by a distinctly clear-cut border which circumscribes a roundish, or even quite round, dense area usually projecting from the right side of the mediastinum. This latter variety of cysts is generally single, and occasionally the shadow cast by teeth or pieces of bone may be demonstrated, otherwise only a probable diagnosis is warranted, except in such a case as mentioned by Dr. Hall, where convincing proof is obtained in the expectoration. If, however, repeated examinations over a

FIG. 2. Tuberculosis in upper half of each lung. Positive T. B. sputum. Sharply defined shadow at hilus of right lung, probably a dermoid cyst. Has not increased in size during several months' observation.

considerable period of time fail to detect any marked change in the size of the cyst and no evidence of secondary deposits appears elsewhere in the chest, a complement fixation test being negative and the general condition of the patient good, the diagnosis of a dermoid cyst is greatly strengthened (Fig 2).

A cyst may be overlooked, especially if its detection be interfered with by the heart shadow. The writer had an experience of this kind about eighteen years ago, before the screen examination occupied the prominent place that it does today. He failed to detect the cyst, which was demonstrated by necropsy, but was impressed clinically with the large area of transmission of the cardiac impulse to palpation. This should have attracted attention to some lesion in the medias-

tinum, as neither the size of the aortic or heart shadow nor the intensity of the heart-beat warranted any such transmission.

Primary sarcoma frequently has its origin in the thymus or thyroid, and may assume very large dimensions, both in the lateral and anteroposterior diameters, causing severe dyspnea and cyanosis, a fact which was particularly impressed upon the writer by an examination of a patient in the prone posture, who was found, after the plates were developed, to have such a

FIG. 3. Sarcoma of mediastinum apparently starting from the thymus. Verified post mortem.

mass. The severity of the dyspnea and coexistent cyanosis was alarming when the patient was assisted from the table. These tumors generally have a roundish shape with a clear-cut border (Fig. 3).

Cold abscess frequently presents an appearance simulating that of a new growth. Its presence is indicated by a dense shadow which overlaps bilaterally that of the spine with its long axis vertical (Fig. 4). It has been my observation that the greatest transverse diameter is apt to be near the middle of the abscess. An ordinary abscess casts a dense shadow which may present itself beyond the edges of the mediastinum, but the diagnosis of this shadow will depend largely upon the clinical history.

Aneurism generally presents but little difficulty in diagnosis. A pulsating, circumscribed tumor with increased breadth in the mediastinal shadow, and a heart situated low, with a flattened left ventricular margin are *x*-ray signs considered diagnostic. Occasionally a case is seen in which the pulsation is diminished, or even lacks expansile pulsation, and which may present some difficulty in correct interpretation. The position and shape of the heart

FIG. 4. Large cold abscess situated behind and extending below the heart. Verified post mortem.

just mentioned will prove of value in making a diagnosis. In a case of this kind the post-mortem examination will probably reveal the aneurismal sac filled with an old organized blood-clot, leaving a practically normal-sized opening through the original channel of the aorta.

An aneurism may simulate, however, the appearance of a cancer of the lung or a tumor of the mediastinum.

One or more masses may signify the presence of tuberculous glands, or may indicate a primary or secondary cancer. The shadows cast by these are practically similar. A distinguishing point from the source of origin is that tuberculous masses are generally found in the posterior mediastinum, while cancerous nodules are more frequently in the anterior mediastinum,

with the exception of a carcinoma involving the esophagus, which should be mentioned in the growths of the mediastinum. This condition requires confirmation by the aid of an opaque mixture in the esophagus.

New growths in the lung are subdivided under the heading of benign and malignant.

If we exclude the massive deposits frequently found in pneumoconiosis from the list of the new growths, benign growths in the lung are very rare. I have never seen a case of echinococcus cyst. These, however, do occur and appear in the lower lobe of the right lung. Dr. Hall reports to me that he saw in his own practice a case of echinococcus cyst in the lower lobe of the right lung, which was verified post-mortem and by the microscope. This case was observed a number of years ago, before *x*-ray examinations were made.

Malignancy of the lung is divided into two classes, primary and metastatic.

Primary sarcoma of the lung is very rare. The writer has no proved case to report, but the clinical diagnosis of primary sarcoma of the apex of the right lung seems warranted in the following case:

Male, aged twenty-three, referred by Dr. Arneill, for an *x*-ray examination Jan. 24, 1916. I am indebted to him for the following history and physical findings: The chief symptom was a dull pain in the right back between the shoulder-blade and spine, also in a similar locality in the right chest and axilla. Has had the pain in the back for six or seven months. A cough has been present for four months, with very little expectoration. Had an attack of grippe about one month ago, with fever. Has lost considerable weight, and there is at present considerable numbness along the course of the right intercostal nerves. Appetite and digestion fair. Physical signs: right side shows diminished expansion, right apex and right infraclavicular region to third rib are dull. High-pitched blowing breathing over the area of dulness, also whispered pectoriloquy, high-pitched blowing breathing over the right back to the middle of the scapula. No signs of moisture detected in the chest. Left radial pulse considerably stronger than the right. Pulse 96. Temperature 99.2° F. Heart dulness normal, also the heart sounds.

The *x*-ray examination showed a uniformly dense, roundish shadow involving the upper part of the right lung, with a clear-cut border and no sign of involvement of contiguous lung tissue. No other pathology shown in the lung or the mediastinum (Fig. 5).

Diagnosis. New growth in the upper part of the right lung, probably primary sarcoma. The patient died within two months from the time of examination.

FIG. 5. Clinically this is considered a primary sarcoma of the right lung. For history and physical findings see text.

The primary type of carcinoma is not common, but it occurs with sufficient frequency to make the roentgenologist bear this disease in mind in all lung cases in which the *x*-ray, clinical and laboratory evidence do not warrant the diagnosis of any of the more common pathological conditions. Especially is this so when the symptoms are distress or pain in the chest, dyspnea and the presence of bloody or prune-juice expectoration. In looking over the literature, the writer finds several descriptions of this condition, and takes the liberty of giving the following opinions:

Carman considers a dense lobar shadow with smaller areas suggesting metastasis as characteristic.

Christie divides primary cancer into two types: infiltrative and miliary.

Infiltrative is a roughly circular shadow extending outward from the hilus, shading off into the lung shadow and with proc-

esses radiating into the lung. Outside this area are evidences of congestion. In addition to this picture, a few nodules with indistinct edges surrounding the central shadow or in relation with the bronchial trunks near the periphery complete the characteristic picture.

Miliary type has diffuse nodulations throughout the lung with hazy periphery and surrounding zone of congestion.

Holmes and Ruggles state that primary cancer is practically always unilateral and presents two types: nodular and infiltrative. The former consists of dense rounded masses occurring near the hilus, and sharply marked off from the surrounding lung tissue.

The infiltrative type arises from the bronchus, and infiltrates the lung along the bronchial ramifications, causing an increased density of the lung markings, or it may involve the surrounding lung tissue and be seen as a mass with fairly smooth edges, except for the advancing margin, which is irregular.

A number of other observers recognize two divisions of cancer, namely, that of a lobe and that of the hilus, also that hilar lesions predominate over lobar, and that the majority of hilar lesions invade the parenchyma in their progressive development.

The writer reports 2 cases of primary carcinoma of the lung, verified by necropsy and pathological examination. One of these cases is presented through the courtesy of Dr. Bronsis of the Jewish Relief Society (Fig. 6).

The metastatic deposits of cancer may be general in both lungs, or confined to one lung. The lesions on the *x*-ray plate consist of general nodulations in the lung or localized deposits in the line of the lung markings, generally involving the lower half of the lung, and apparently starting from the hilus. The appearance of metastatic deposits is practically that mentioned for primary lesions and a careful necropsy may be necessary for differentiation, provided the clinical history does not give convincing evidence (Fig. 7).

Where the pleura is primarily involved in the metastasis before the lesions are demonstrated in the lung, the first sign detected may be only a restricted motion of the diaphragm on the affected side.

Metastasis of the lung is comparatively frequent, especially secondary to carcinoma of the breast, and if an *x*-ray examination were made in all cases of this latter disease, some radical operations for the removal of the breast would be deemed inexpedient.

FIG. 6. Primary carcinoma extending upward from root of left lung. Appearance simulates that of aneurism. Verified post mortem.

FIG. 7. Metastatic carcinoma of lungs secondary to carcinoma of stomach. Verified post mortem.

In the differentiation between benign and malignant growths of the lung it is a fairly accurate statement that benign growths are sharply defined, whereas in malignant growths, the absence of a clear-cut border, with a hazy area extending into the surrounding lung structure is to be expected. Also, it is the general experience that sarcoma presents a more sharply-defined border than is found in carcinoma. This fact is well exemplified by the clear-cut contour of rounded sarcomatous tumors of the mediastinum.

Benign growths and circumscribed shadows simulating the appearance of growths must be considered in the differential diagnosis. Among these, mention is made of cysts, abscesses, encysted empyema, syphilis, massive deposits from pneumonoconiosis, unresolved pneumonia, interlobar effusion, bronchiectasis and tuberculosis.

Whereas the clinical evidence will, as a rule, readily differentiate most of these conditions from cancer, yet from an *x*-ray standpoint alone, differential diagnosis from cancer is often difficult, if not impossible.

The appearance of a cyst has already been described.

Abscess of the lung is generally single and casts a shadow of fairly uniform density, though not infrequently the center of this shadow presents a lighter area, and at times a fluid level can be detected. The margin of this shadow may be clear-cut, but it usually has a hazy irregular border. The shape of the abscess, in the writer's experience, has most frequently been found either roundish or elliptical.

Encysted empyema usually presents a sharp border, clearly separated from the lung structure, and casts a uniformly dense shadow.

There are no changes in the lung that are considered peculiar to syphilis. A gumma may exist and be indicated by a massive shadow in any part of the lung, with probably small, nodular, hazy shadows in some other part of the same lung. Another type of this disease may show more or less extensive parenchymatous involvement characterized by irregular nodular shadows, varying in size, with hazy margins. We may also find only increased density of the hilus with increased area of shadows extending into the lung substance.

A valuable aid, however, in the correct interpretation of these shadows, may be found in the cardiovascular changes in the chest which are so frequently found in syphilis.

A positive Wassermann is an even more valuable aid, and a more important one still is the disappearance either partially or entirely of the lung involvement under specific medication, for it must not be forgotten that syphilis and other diseases of the lung may coexist, or that a positive Wassermann does not necessarily signify that the lung changes found in a given case are due to syphilis.

Pneumonoconiosis is manifested by small nodular deposits distributed in the line of the bronchial radiations, and may be mistaken for a similar type of peribronchial deposits from cancer. If carefully observed, however, the hazy edge of the cancerous nodules shading off into the inflammatory lung tissue is in marked contrast to the appearance of the more sharply cut edges in pneumonoconiosis. Furthermore, the latter nodules are bilateral and fairly symmetrical, while in cancer the nodules may be unilateral. The heart shadow is usually enlarged in pneumonoconiosis.

Definite massive deposits from pneumonoconiosis when situated above the hilus of the lung may present an appearance of aneurism. Such a case was reported by Dr. Sewall in *The American Journal of the Medical Sciences* for January, 1906.

An *x*-ray examination was made by the writer of this case on May 5, 1904. A systolic bruit was detected by Dr. Sewall over the lower half of the right scapula, which was suspected, in view of the suspicion of syphilitic infection, to be caused by a thoracic aneurism.

The report based upon the *x*-ray examination of this case is as follows: Heart is situated low in the chest. The shadow of the aorta seems broader than normal. Both sides of the diaphragm move fairly well, the left more than the right. There is seen best from the back, projecting into the right lung, a rather dense shadow, some-

what rectangular in shape. It fuses on the inside with the shadow of the base of the heart and ascending aorta, with a surrounding clear space externally above and below. No pulsation is detected in this shadow, but the shadow is of uneven density. In each lung are seen a number of dense circumscribed deposits.

Diagnosis. Circumscribed mass in the right lung extending toward the median line of the sternum. Negative for aneurism.

Necropsy Report. At the root of the right lung is found a hard solid mass ovoidal or pyriform in shape, 4 in. long, 3½ in. wide and 2½ in. deep, which reaches the posterior surface of the lung. Hard black nodules the size of duck shot are scattered through the upper lobe. On section, the mass at the root of the lung is found to be black in color and gristly in resistance.

Diagnosis. Anthracosis.

Massive deposits may also simulate the appearance of cancer.

Unresolved pneumonia presents an appearance which, without the aid of the clinical history, may be impossible to differentiate from cancer.

In interlobar effusion we find a shadow sometimes described as a hanging shadow from the hilus, and if not too extensive, the shape of this shadow and its direction should conform to the line of the fissure. If, however, the effusion is quite extensive, its shadow may obscure nearly the entire lung. The writer has observed in 2 such cases that the costophrenic angle is not dense like the remaining shadow, in contrast with the shadow cast by a general effusion obscuring cancerous deposits or an extensive pleurisy with effusion from any other cause.

The condition of bronchiectasis is typified chiefly by marked thickening of the lower radiations on each side, and, according to the extent of the lesion, there may be small pseudo cavitations. In cancer, the lesion is generally unilateral and, whereas it may be confined to the lower lobe, it frequently extends directly outward from the hilus of the lung as well. The clinical diagnosis of bronchiectasis is generally self-evident.

When tuberculosis is associated with areas of caseous pneumonia, the lung changes may closely simulate those of cancer. But in this latter condition, the lesion seldom involves the apex, while in tuberculosis, the apex is generally definitely

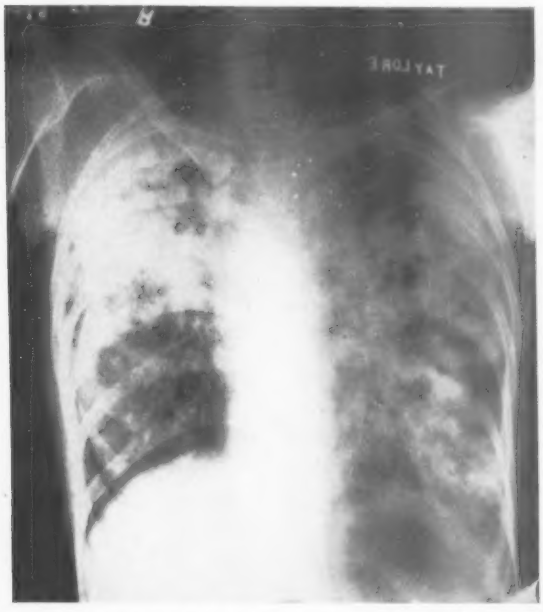

FIG. 8. Extensive tuberculosis both lungs. Positive T. B. sputum. Appearance simulates carcinoma of the lung.

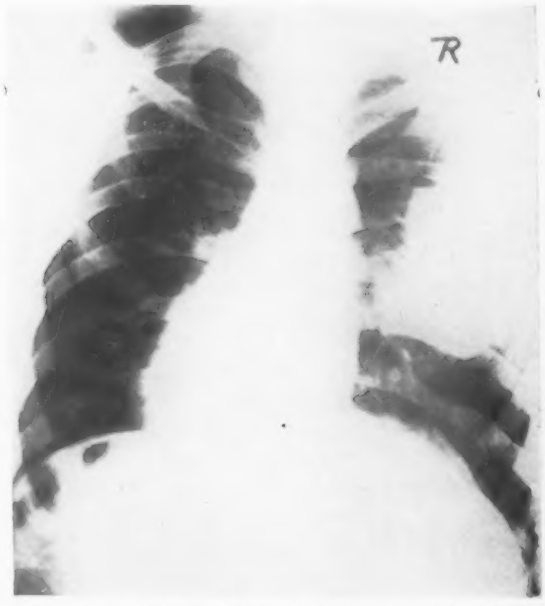

FIG. 9. Probable syphilis of right lung. Symptoms: pain in chest, occasional shortness of breath, very little cough, about normal weight. Had pneumonia two years ago. 4 plus Wassermann. Definite improvement under antiseptic treatment.

involved, and if there are hilar shadows in each condition, the larger size of these and their irregular edges with the changes above described, extending into the surrounding lung tissues, are valuable aids in the differential diagnosis (Fig. 8).

In the miliary type of tuberculosis, the deposits are smaller, as a rule, than those found in cancer, and are apt to be fairly uniform in size, and will probably have a hazy border. However, the writer has observed one case of general carcinomatous deposits, as far as determined by post-mortem examination, in which the deposits were small, like those ordinarily found in miliary tuberculosis.

SUMMARY

The *x*-ray furnishes valuable evidence in all new growths within the chest, and in some of these conditions a positive diagnosis can be made from its use alone.

It is considered, however, that in all cases of new growths, the *x*-ray should be combined with the clinical and laboratory evidence, before a positive diagnosis is made.

Primary carcinoma of the lung presents, generally, a fairly definite group of symptoms as well as a rather typical *x*-ray picture, and, although it is not common, yet it occurs sufficiently often for the clinician and the roentgenologist to bear the possibility of its existence in mind, when the findings in a given case are not satisfactorily accounted for by the diseases ordinarily found in the lungs. When the combined evidence is before us, mistakes in this diagnosis will be greatly lessened.

NEW GROWTHS WITHIN THE CHEST*

BY J. N. HALL, M.D.

DENVER, COLORADO

WE believe the following statements will justify us in presenting to this Association the general subject of the Diagnosis of Malignant Diseases Within the Chest:

It is realized everywhere that such disease is becoming more common, the proof from autopsy statistics alone being sufficient to establish this point.

The diagnosis is made in 80 or 90 per cent of cases in certain clinics, but in only occasional instances in others. It is obvious that, if the knowledge and facilities which enable certain physicians to make the diagnosis in most cases were in the possession of all physicians, failure of diagnosis would be infrequent. We are of that number who believe from experience that the diagnosis can be made in a very great majority of cases.

Malignant disease within the chest chiefly involves, primarily or secondarily, the following organs:

The lungs, including the bronchi,
The pleurae,
The mediastinal glands,
The thymus,
The thyroid,
The esophagus.

Teratomata should also be considered.

The Lungs and Bronchi. It is in this field that the recently noted increase of malignant disease has chiefly occurred, and the opinion is general that the source of the growths lies in the frequent residual lesions left in the wake of the great epidemic of influenza. The frequently reported evidence of origin from bronchiectatic cavities, tuberculous cicatrices, and other foci of inflammation is noted on every hand. It is probable that the cases noted in the German literature, as originating in the miners of cobalt, nickel and bismuth, in the Schneeberg district, and in the sandstone workers near Dresden, are, like the occasional cases in this country in miners, the result of irritation of lungs, bronchial mucosa or bronchial glands by the various irritants mentioned. Doubtless a chronic inflammatory lesion always precedes the malignant growth. The frequency of cancer of the bladder in

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922. Discussion of this paper and the others in the same symposium will appear in a subsequent number of the JOURNAL.

anilin workers is of interest in this connection. One of us[1] saw cancer of the lung in an oil refinery employe subjected in his work to exposure to very irritating gases. The case reported by Chevalier Jackson, of cancer developing about a foreign body which had remained in the bronchus for thirty-five years, is worthy of mention.

The preponderance of males in the case reports is doubtless in part due to the fact that occupational disease, such as pneumonoconiosis, as seen in miners, marble workers, grinders, and others, which disease predisposes to malignancy, is practically limited to the male sex.

The preponderance of cases after forty years of age is the natural result of the circumstance that a long-continued inflammatory process precedes malignant change.

The development of carcinoma or sarcoma shortly after trauma has been observed, but a causal relation is scarcely established.

Why right-sided disease is more frequent is not known, but the relatively greater bronchial and glandular preponderance upon this side is probably a factor.

The histology of the growths in the lung has been extensively studied by others, and we shall in this article speak in general terms only of cancer and sarcoma.

Primary Cancer. Pfahler mentions the sharply-defined, nodular type of cancer at the root of the lung, and the infiltrating type, spreading outward and upward from the hilus, especially along the bronchial tree. The mediastinal shadow is often broadened. The disease occasionally spreads along the thoracic duct, and chylous ascites or hydrothorax may result. The tendency of inflammatory thickening to involve the bronchi running downward from the hilus is well recognized, especially since the great epidemic. This forms a valuable differential criterion.

Secondary carcinomatous involvement of the lung is very common. Warfield, in 516 autopsies in cancer of the breast, found the lung involved by metastasis 178 times. While direct extension through the chest wall in breast cancer leads to metastasis in the lung of the same side, extension from growths elsewhere in the body commonly leads to a bilateral development in the lungs.

Carman believes that cancer is often carried by embolism through the blood-vessels, although lymphatic distribution is probably the rule.

Metastasis from primary cancer of the lung is most frequent in the lymph-nodes, next, in the liver, while the bones and other organs are occasionally affected.

Primary sarcoma spreads outward more especially about the median fissure on the left, or the median lobe on the right. Secondary sarcoma, however, is more often seen as a late development in sarcoma of the testicle. Nodules appear in the parenchyma of the lung, emboli having been carried to the terminal vessels through the blood stream. Metastasis of hypernephroma to the lungs is common enough to justify Pfahler's statement that the lung should always be examined roentgenologically in such cases. Miliary involvement outward from the root of the lung is the rule.

Knox's recent report upon the relationship of massage to tumor metastasis is of extreme interest. In animals, gentle massage for a total period of two to five minutes, distributed over several days, has repeatedly resulted in the development of embolic metastasis in the lungs. Only tumors which grow readily when implanted in subcutaneous connective tissue take readily in the lungs. With Dr. I. C. Mierley, we have just examined a patient with metastasis to the glands in the right lower abdomen, a few weeks after the removal of the right testis for sarcoma. He casually stated that he had had a chiropractic treatment of these glands a few days before. The possibility of metastasis to the lungs so monopolized my attention that I desisted from the examination and asked if he had a cough; then if he had expectoration, and then if it was bloody. I received a positive answer to all three questions. A plate of the lungs, made shortly afterwards, showed extensive pulmonary metastasis.

Symptoms. These are commonly due more to the inflammation accompanying

[1] Dr. Hall.

the growth than to the growth itself. A dry cough is generally the first symptom noted. It may constitute the only evidence of disease even for several months. A thin mucous expectoration soon follows, and not infrequently a blood-stained, tenacious, even jelly-like sputum.

In the primary cases, further symptoms do not develop until the growth of the tumor mass or masses causes erosion, giving rise to hemorrhage, or pressure, leading to pain and notable dyspnea. Marked weakness, cachexia and fever appear later. A terrible feeling of oppression in the chest is noted when the growth is a massive one. After considerable pressure has developed, secondary bronchiectasis may give rise to a purulent sputum or the addition of purulent elements to the sputum. The presence of fever is certainly not to be taken as against the diagnosis of cancer, since it is present in at least half the cases. It may arise from associated suppurative processes, or directly from the malignant process. The appearance of effusion, generally bloody in character, and producing, if large enough, the usual cardiac displacement, is to be taken as evidence of malignant pleural involvement.

The varying character of the dyspnea is worthy of study. A very moderate shortness of breath is the rule early in the disease. With the appearance of the effusion, the dyspnea increases, as also in case of extensive infiltration of the lung. The extreme types signify that extension to the mediastinal glands has brought about pressure upon one main bronchus, or in the worst instances, upon the lower trachea.

Compression of the recurrent laryngeal nerve upon either side, or of the vagus, is accompanied by exaggeration of the cough, with hoarseness, stridor, or inspiratory dyspnea. Irregular, slow or rapid pulse may result from compression of the vagus. A decided increase in the amount of expectoration suggests that the growth is breaking down. The greenish discoloration occasionally seen is probably due to gangrene in a compressed lung and is of very bad significance. Particles of the tumor may be recovered from the sputum.

Dysphagia is an occasional symptom—due either to pressure upon the esophagus or to involvement of the nervous mechanism.

Irritation of the sympathetic may cause contraction of the pupil, with flushing, while more complete compression of the nerve many result in pallor of the face and neck, and dilated pupil.

In cancer of the right lung, especially, the superior vena cava may be compressed, with edema of the body above the waist line. Dilatation of the external veins of the chest often follows compression of the internal mammary vein.

Physical Signs. Changes in the percussion note may not be manifest until the growth assumes such size as to give rise to dulness, or the presence of a pleural effusion causes flatness over the affected area. The most notable flatness is found in case of extension to the pleura, where solidified lung, vastly thickened pleura and perhaps a small effusion unite to produce phenomenal solidity, as in 4 of our recent cases. In one of these the right side of the chest was greatly enlarged. Flat tympany or hyperresonance may be found when a bronchus is compressed, or an amphoric note, if a cavity develops. The possibility of pneumothorax must be considered, although it is a decidedly rare occurrence. Displacement of the heart and mediastinum, which should be carefully sought for in every case, is usually due to effusion, but, as in one case of mine, may be due solely to the massive character of the growth in the lung and pleura.

Upon auscultation, we may hear pleural friction, bronchial respiration, decreased respiratory murmur, moist or wheezing rales, increased or diminished voice sounds or amphoric sounds, all interpreted precisely as in other lung affections. The heart sounds are frequently heard with unusual distinctness through solidified lung or pleura, or an effusion. Vocal fremitus is increased or decreased as in other conditions, and has no especial significance. The wide transmission of a blowing sound originating at a point of narrowing of a bronchus, from compression, commonly by a cancerous bronchial gland, is occasionally noted—the cornage of French writers. Pleural effusion

probably occurs in half the cases, and is generally yellowish or bloody. Because of cancerous involvement of the pleura, which itself gives rise to extensive dulness, it is often less in amount than expected from the physical signs. The effusion may become purulent. Pericardial effusion may occur. The withdrawal of a small amount of bloody effusion in any case strongly suggests malignancy.

Diagnosis. In fairly typical cases we may expect a slow onset, with dry cough, slight sputum, later sanguineous, and still later, frankly bloody and gelatinous. As the disease advances, pain, fever in half the cases, loss of flesh, and the appearance of such physical signs as we have mentioned should strongly suggest malignant disease. The appearance of palpable glands about the neck or axillae, noted in many of the cases, is extremely suggestive, and the withdrawal of a bloody exudate from the pleura establishes a presumptive diagnosis. The finding of roentgenological evidence such as we have mentioned ordinarily clears up all doubt. The histological examination of an excised gland is conclusive, and should be carried out in most cases.

When the history and the presence of enlarged glands suggest tuberculosis, the sputum should be examined with especial care. The finding of bacilli does not in the least controvert a diagnosis of malignant disease, since, as we have seen, tuberculous processes so commonly serve as a starting point for the growths we are considering. Yet—such a finding calls for a careful sifting of all evidence before making a diagnosis of new growth.

Fishberg rightly speaks of the rarity of pain and dyspnea in early tuberculosis, but these symptoms are common in cancer. The nodules shown upon the *x*-ray plate in miliary distribution of cancer are larger and more dense than those of tuberculous origin. The absence of fever suggests cancer rather than tuberculosis, although, as noted above, half of the cases of cancer run a febrile course.

Because of the resemblance of syphilitic infiltration of the lung, a Wassermann test should be made in every case. Leukemic infiltration may be definitely recognized by the blood examination, and Hodgkin's disease by the characteristic distribution of the glandular involvement. Histological examination of an excised gland makes the diagnosis positive. The free use of the exploring needle is advisable in case of doubt as to the presence of empyema or pleural effusion of non-malignant character. The history, the febrile course, the expectoration and the *x*-ray appearance should readily serve to differentiate lung abscess. In a recent Denver case, an aneurism was found at post-mortem examination after a diagnosis of malignant disease had been made. Certainly, in most instances, the presence of a Wassermann reaction, of arterial changes, of accompanying aortic disease, tracheal tug, expansive pulsation, demonstration of pulsation by use of the fluoroscope, and the clearly outlined characteristic mass upon the *x*-ray plate will serve to prevent this error. The finding of the tracheal diastolic shock described by one of us[2] should absolutely exclude solid tumor.

In one case, thoracic aneurism and a mass from cancer of the esophagus were present at the same time giving a very confusing picture clinically as well as roentgenologically, yet the diagnosis was possible.

Jacobaeus produces an artificial pneumothorax before raying the chest, and is enthusiastic as to the results. Such a course is, in our opinion, rarely called for.

Complications. We have mentioned bronchiectasis and hemorrhage. A recent case died suddenly apparently of pulmonary embolism, but we had no opportunity to prove it by autopsy. Thrombosis of the vena cava and the various nerve involvements have been considered. Herpes zoster occasionally develops along an intercostal nerve compressed by the growth. Gangrene, atelectasis, metastasis and even external perforation may occur.

The prognosis speaks for itself, although we admit the possibility of surgical cure in rare cases in the future. The average case dies in twelve to eighteen months, but certain cases, perhaps, especially spindle-celled sarcoma, may last five years.

Malignant Disease of Pleura. We have considered the condition as a late develop-

[2] Dr. Hall. *Am. J. M. Sc.*, Jan., 1900.

ment in affections of the lung. As a distinct disease it is commonly unilateral. There are the usual symptoms of pleurisy, pain, cough, dyspnea and loss of weight, generally without fever or expectoration. The needle passes with difficulty through the leathery pleura, and commonly withdraws but a small amount of bloody fluid. The density of the shadow upon the *x*-ray plate in cases of great cancerous thickening of the pleura is rarely surpassed by any pathological conditions. The development of inoculation metastases along the needle path gives opportunity for a conclusive histological diagnosis.

In one of our cases, these developed after every aspiration. The disease spreads by metastasis to the lungs and to surrounding lymph-nodes. After tapping, the displaced heart rarely returns to its normal position, because of the infiltration around it, and little relief is experienced from removal of fluid in the average case. The walls of the cavity involved are inelastic, and the removal of fluid leads to further hemorrhage, so that the fluid often becomes more bloody with successive aspirations. Little is commonly gained by this method of treatment.

In a case which has never been tapped, a yellowish, serous fluid may be obtained upon aspiration, but this need not prejudice us against the diagnosis of malignant disease. A bit of tissue which may be utilized for examination may be found in the needle. Endothelial cells, or even distinctive malignant ones, may be present in the fluid.

Secondary malignant disease of the pleura is vastly more frequent than primary, the source being generally cancer of the breast, stomach or mediastinum. Sarcoma is less frequent than cancer. The average case does not live a year.

Mediastinum. Malignant tumors of the mediastinum arise primarily from the mediastinal glands or from the thymus gland, in the great majority of cases. An aberrant thyroid gland may be the point of origin. Cancer of the esophagus develops a mediastinal tumor, either from the esophageal disease or secondary adenitis. Sarcoma in one of its forms is the most frequent of mediastinal growths. Lymphosarcoma, Hodgkin's disease and leukemic growth are not infrequent. Teratomata are rare. Secondary growths are common from any neighboring malignant affection.

The symptoms are those of pressure rather than of invasion of neighboring tissues. Cough arises when a bronchus is compressed and irritated, or the recurrent laryngeal nerve affected. Expectoration is less notable than in the chest involvements already considered. It may become bloody. Dyspnea appears when the trachea or the bronchial tree suffer from compression. It is often paroxysmal. In our experience, terrible paroxysmal attacks of dyspnea are much more characteristic of mediastinal tumor and aneurism than of any of the other conditions we consider. The sudden expansion of the aneurism under vascular stress, or of the tissues of the mediastinum, provokes even a fatal dyspnea. One of us[3] saw with the late Dr. E. P. Hershey, a case of gumma, presumably arising from the mediastinal glands, and proved by post-mortem examination, which pulsated so freely that we at first believed it to be an aneurism. In a pregnant woman seen with Dr. H. R. McGraw, death occurred during labor from suffocation, due to sudden hemorrhage into the thyroid gland, in part of substernal situation.

Phillips quotes a case of compression of the aorta by a mediastinal tumor, with gangrene of the lower extremities. Stridor, aphonia, sympathetic nerve disturbances, dysphagia, enlargement of veins, cyanosis, localized edema, secondary adenitis, pupillary signs, recurrent paralysis, pleural effusion, and most of the percussory and auscultatory signs already considered, may be found. Certain signs are more characteristic of mediastinal growth, especially deviation of the trachea, fixation of the larynx, compression of the spinal cord, the appearance of a palpable tumor at the sternal notch, marked dysphagia and great wasting. The deformity of the sternal section of the chest wall is common to sarcoma, aneurism and Hodgkin's disease, and erosion may occur in any of them, but is least likely in sarcoma. The pain is generally less severe and "boring" than in

[3] Dr. Hall.

aneurism. The sitting posture, as the disease advances, leaning forward with head perhaps thrown backward, is distressing even to the observer. Cachexia is marked in many cases.

As a rule, tumors showing in the anterior mediastinum are sarcomatous, those in the posterior space being commonly tuberculous, especially in children. An invasive growth is more likely to be carcinomatous than sarcomatous in character.

The outline of mediastinal tumors is usually sharper than that of growths in the lung. Abscess is ordinarily distinguishable by its etiology, its febrile course, and high leucocyte count. The needle may be decisive. Some of the worst abscesses have arisen from perforation of the esophagus by bones and other foreign bodies, or have been associated with empyema, being, in fact, cases of mediastinal empyema. These cases have been more frequent since about 1917.

Dermoid cyst can rarely be diagnosed unless shadows of teeth can be obtained, or, as in a recent case in St. Joseph's hospital, sebaceous material and hair are coughed up. In case of doubt, repeated *x*-ray examinations may show the growth of a malignant tumor. The Wassermann test is imperative.

These cases are generally fatal in from six to twelve months. We showed a case of spindle-celled sarcoma, proved by histological examination of an excised gland, in four successive annual clinics at the Denver City Hospital, but such a duration is exceptional.

In conclusion, we should state that metastasis of malignant tumors to the chest is so common that roentgenological examination of the thorax before operation of such cases is as necessary as the customary palpation of the liver for metastatic nodules.

We have said little of treatment. Unless the growth can be checked in some degree by the use of the *x*-ray, we can offer but little hope.

DIAPHRAGMATIC HERNIA OF THE STOMACH

BY PEDRO L. FARINAS, M.D.

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THE case here reported is the only one known to me in the Cuban literature which has not only been diagnosed, but also operated upon and cured.

Male, aged twenty-four years, referred to me by Dr. Valentin Diaz of Ciego de Avila for roentgen-ray examination of the alimentary tract.

History. On February 2, 1918, he was wounded in the left thorax (infraaxillary region) through the sixth intercostal space. He had some cough and bloody expectoration, but the wound healed by first intention, and two or three months later he began to complain of digestive disturbances and pains radiating to the shoulder in the side wounded. His condition was getting worse; after February 4, 1921, he vomited very frequently, had hematemesis and melena and was not able to take any solid food; as a consequence, he lost weight and was very anemic.

X-ray Examination. Fluoroscopy. There was noted in the left side of the thorax and above the diaphragm a light shadow, dark and clearly visible, which changed with the respiratory movements. There was no displacement of any thoracic organ; the diaphragmatic movements were synchronous and somewhat reduced in the left side.

With the opaque meal it was noticed that the infradiaphragmatic part of the esophagus was turned upward to the left. The stomach began to fill abnormally, and was constricted in the cardia; the light shadow seen above the diaphragm was filled almost completely, and the stomach appeared in two sections limited by the constriction; one, supradiaphragmatic, which was the fundus and the cardia, and the other, infradiaphragmatic, which was the antrum pylori.

At the end of six hours the stomach was nearly emptied, and in twenty-four hours

the head of the opaque meal was beyond the splenic flexure of the colon, which remained in the abdominal cavity.

Radiography. Figure 1 shows an hour-glass form of stomach high up in the left chest; also the diaphragm dividing the stomach into two portions.

FIG. 1. Diaphragmatic hernia of the stomach.

FIG. 2. Stomach after operation.

Figure 2 shows the same stomach after recovery.

Operation. Dr. Felix Pages, surgeon to the Quinta de Dependientes, operated on the case and furnished the following information:

"Our technique was very simple. The incision extended from the ensiform appendix to the umbilicus. The opening through the diaphragm was thoroughly explored and extensive adhesions were found which were separated. This allowed the stomach to be returned to the abdominal cavity. The hernial ring was sutured without much difficulty. The air was extracted from the pleural cavity by means of a puncture through the sixth intercostal space in the axillary region. By the seventh day, the patient was eating without any trouble and a subsequent roentgenogram showed the stomach occupying a normal position.

CONCLUSIONS

1. In some cases the symptoms cannot lead to the diagnosis, and the roentgen-ray examination is needful.

2. It is a good practice to inspect systematically the thorax in all cases of digestive tract screen-examinations.

SACROILIAC ARTHROSIS OBLITERANS*

BY EDWARD S. BLAINE, M.D.

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CHICAGO, ILLINOIS

INDIVIDUALS who seek medical relief for varying degrees of pain and discomfort in the lower back require careful *x*-ray study, as well as the usual clinical investigation, in the search for the cause of the symptoms complained of. During the routine examination of a large series of lower spine studies (approximately 1,800) a group of 18 was found to present unusual changes in the sacroiliac joints. These are the subject of this presentation. In these particular cases, the patients complain of a dull pain, and some soreness and stiffness of the back, with an uncomfortable feeling in the lower spine. These more or less vague symptoms in most of the cases came on gradually, and slowly increased in degree during a period of from several months to a year or more. The patients do not recall any particular time when the symptoms began. Injury to the spine has been ruled out in the entire group. A marked discomfort is noticed by nearly all the patients in the group under discussion, some of whom have had to discontinue their regular work, particularly those whose duties require them to stand on their feet or work at a bench all day. There are clinical evidences of a more or less degree of spinal rigidity, a considerable limitation of motion of the lower back, and a slight tenderness, which is fairly well localized over the sacroiliac joints and lower lumbar spine. In several of the cases, there is an obliteration of the normal lumbar curve. There is also found a slight to marked atrophy of the erector spinae muscles, sometimes unilateral, and often bilateral. The discomfort is found to be much increased when the patient has to sit on a hard-bottomed chair or similar unyielding seat. A jolting motion aggravates the symptoms. The condition is very slowly progressive and extends over a long period of time, with periods of comparative recession of the symptoms.

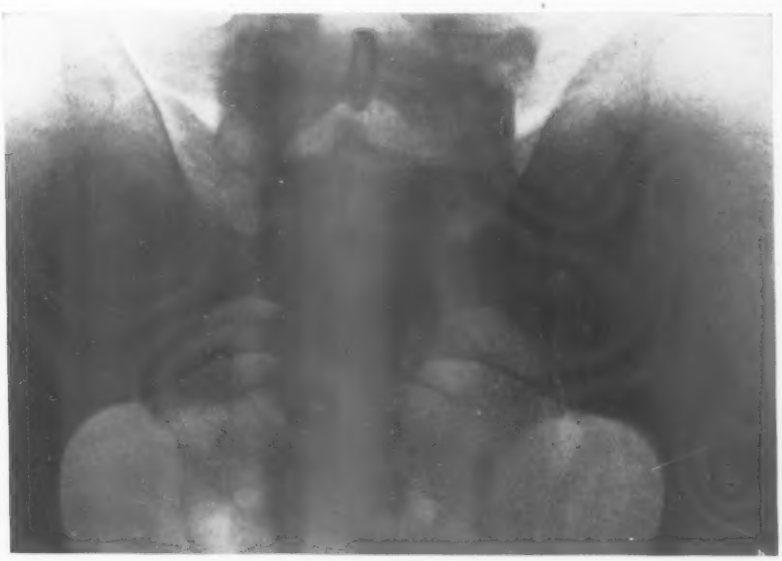

FIG. 1. Normal sacroiliac joints. Patient, male, aged twenty-six. Weight, 145 lbs. Presents average normal contour and sharp, smooth, regular shadows of all articular surfaces, with even interarticular distances.

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., September 12–16, 1922. Discussion of this paper and the others in the same symposium will appear in a subsequent number of the JOURNAL.

No rise in temperature was discovered in any of the cases.

The *x*-ray shadow manifestations of the condition under discussion represent gross intrinsic joint changes in the sacroiliac synchondroses. The majority of cases are definitely bilateral in involvement, but some are found to be unilateral sacroiliac conditions. Obviously, intimate or microscopical changes cannot be demonstrated by the *x*-ray plate regardless of wealth of shadow detail or excellency of stereoscopic effect, a fact which prevents conclusions being arrived at as to the precise pathology present. In several of the cases observed, there have been similar joint changes in the lumbar and dorsal joints, but this exposition concerns those cases in which the sacroiliac lesions are the most striking features.

FIG. 2. Patient, male, aged twenty-six. No direct history of sacroiliac disease; complains of low-back pain. *X*-ray reveals bilateral obliteration of sacroiliac joints, total loss of articular surfaces, fusion of sacrum with both ilia, evidently the result of low-grade joint infection.

The essential alteration is found to be a combination of destructive and constructive changes, sometimes both being present simultaneously. The *x*-ray features seem to indicate to the essayist a very low-grade type of joint infection of marked chronicity. Some of the cases present shadows that apparently indicate active changes, while in others the shadows appear to indicate inactive or healed stages of a joint disease.

A brief consideration of the shadow appearances of the normal sacroiliac joints, as compared with the shadows of the condition under consideration, will reveal that the former has a rather constant appearance in average normal individuals, and can easily be recognized as such in practically all cases which are exposed with the patient in supine position, and anteroposterior projection of the ray. In the normal adult it will be observed that the edges of the articular surfaces are well defined and sharply bordered at anterior margins of the joints, and the interarticular distances are even throughout and of uniform degree of shadow. Both the sacral and the iliac surfaces follow each other from upper to lower margins of the joint. This joint is peculiar in its anatomy, in that its general direction extends from behind, forward and outward, varying in degree of angle with the build and sex of patient. The anterior joint line, in general, is from above downward, parallel to the vertical axis of the body. The line of articulation is usually curved outwards, the upper and lower points being approximately equidistant from the median line. The posterior articular edges of the joint are seen mainly in its lower half, the upper

portion failing to give a definite joint-line shadow in most cases, because this portion is more nearly at right angles to the line of *x*-ray; that is, it faces anteriorly, and thus no shadow of its surface is obtained.

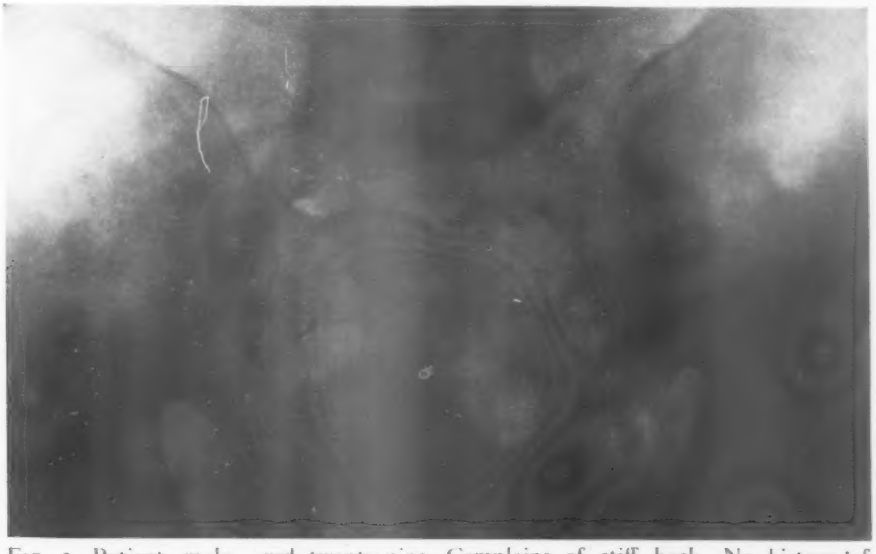

FIG. 3. Patient, male, aged twenty-nine. Complains of stiff back. No history of localized joint infection. *X*-ray reveals bilateral total loss of articular surfaces and resulting synarthrosis. This is a frequent sequence of a joint infection in which destruction of articular surfaces and interarticular structures occurs.

FIG. 4. Patient, male, aged twenty-three. Complains of pains in back; indefinite and not localized. *X*-ray reveals complete loss of both sacroiliac joints (total obliteration); sacrum and both ilia are one bony unit. The changes represent a previous joint infection in which a destructive process occurred.

An early disease in the joint may be deduced by a comparative decrease in the sharpness of the joint edges, these appearing to be somewhat hazy in shadow detail. This may be said to be due to localized edema and swelling of the articular surface tissues as well as the interarticular cartilages, which cause the loss of sharp shadow detail through "scattering." A

further advance of disease in the joint is manifested by shadows which indicate an bony erosion seen to invade deeply into the underlying cancellous bone. A still

FIG. 5. Patient, male, aged twenty-seven. Complains of "dull pain in lower spine"; came on gradually during one and a half years. No history of sacroiliac disease. *X*-ray reveals bilateral obliteration of sacroiliac synchondroses, the destruction of articular surfaces, undoubtedly the result of a joint infection.

erosion of the articular surface edges, which normally are uniform throughout, the further advance is shown by a material decrease in the interarticular distance

FIG. 6. Patient, male, aged thirty-one. Vague history of pain and discomfort in back. No injury or pathology of sacroiliac region. *X*-ray reveals complete loss of both sacroiliac joints, usual shadow evidences of destructive joint process and infection of articular surfaces.

interarticular distance now being apparently increased. In no instance was the between the sacrum and ilium as the two opposing surfaces approach each other,

because of loss, through absorption, of the intervening cartilage which has been softened through disease and which eventually disappears, thus permitting the two bones to come into direct contact with each other. At this stage, the joint condition is easily demonstrated by the *x*-ray shadows. An advanced case will reveal a total obliteration of the involved joint, a synarthrosis resulting, the two contiguous bones fusing into a single bone, in unilateral cases, while in bilateral involvement, the three bones join to form one single bony unit. In certain of the cases, which are regarded as characteristic of osteoarthritis hypertrophica. In fact, the early stages of this condition are quite like an ordinary low-grade arthritic infection, and therefore cannot be distinguished or differentiated from it. The latter stages of this joint condition have a surprising similarity to the shadows that often are found in so-called "typhoid spine."

As every effect has a cause, one seeks to determine the reason for this particular sequence of joint change. The *x*-ray shadows do not establish just what this is; whether any particular microorganism,

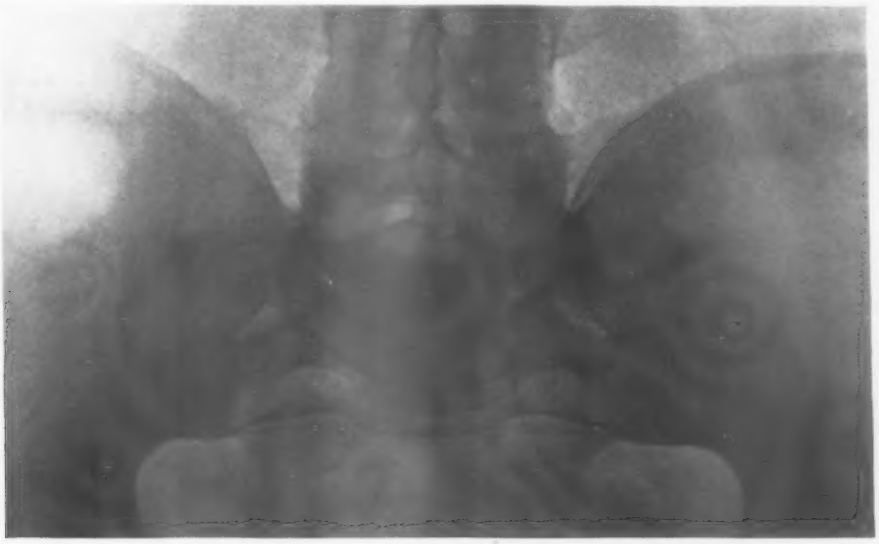

FIG. 7. Patient, male, aged twenty-eight. Complains of stiff back, no symptoms directly referable to sacroiliac region. No injury. *X*-ray reveals complete loss of both sacroiliac synchondroses. Sacrum and both ilia are fused into one bony unit. The shadows represent healed (?) stage of joint infection of articular surfaces and joint cartilages, synovia, etc.

a reparative process is conclusively established by shadows that represent a distinct hypertrophy of bone developing around the obliterated joint, and often extending into the soft tissues in the immediate neighborhood. It is a question whether to regard this hypertrophy as part of the sacroiliac lesion, or a manifestation of a concomitant hypertrophic osteoarthritis. This increased bone seemingly is an attempt on the part of nature to assist to immobilize the joint by an auto-splinting, as it were.

Viewed in certain aspects, the early changes are not dissimilar to some changes toxin or other irritative material is the cause has not been determined. One of the most striking features noticed is the fact that all the individuals in this group of cases are under thirty years of age, several being less than twenty-five years old.

DIFFERENTIAL *X*-RAY DIAGNOSIS

Viewing these cases from the standpoint of differential *x*-ray diagnosis, one will consider:

1. Typhoid arthritis.
2. Septic arthritis.
3. Chronic hypertrophic osteoarthritis.
4. Tuberculous arthritis.

The shadows found in so-called "typhoid spine" or typhoid arthritis present no essential differences from those observed in this series of cases, particularly in the latter stages. There is the same joint destruction and disappearance of interarticular cartilage, and at times a reparative process around the joint. The history, therefore, is an important point, and will greatly assist in the study. No history of clinical typhoid fever was found in any of the cases of this series.

In septic arthritis, the amount of joint change usually depends on the virulence of the invading microorganism and, if severe, will result in a complete joint obliteration, or synarthrosis. I have seen similar joint disappearances follow in a case of puerperal sepsis, the infection having reached every joint below the dorsal spine, without exception.

In cases of chronic hypertrophic osteoarthritis, there is little or no destructive change of the internal joint structures, and this disease is essentially a matter of bone-tissue increase at the edges of articular surfaces. The joint immobilization is present only in the extreme type of this condition, namely, arthritis deformans. Here, too, the articular surfaces present much less change, and the alteration is not that of erosion with absorption or disappearance of the articular surfaces, as is the case in the arthropathy here presented. Then, too, the changes in chronic hypertrophic osteoarthritis occur in many of the joints simultaneously, though not always in the same degree; whereas, in the condition under discussion, they involve usually but one or two joints. Chronic arthritis is seldom found in individuals under thirty-five to forty years of age; while our cases are all in the third decade, that is, between twenty and thirty.

Tuberculous arthritis of the sacroiliac joints is seldom bilateral, and it also differs from the changes here described in that there is a rather extensive softening of the cancellous bone tissue in the bones surrounding the involved joint, and there is usually a far greater destruction of bone than has been observed in the cases under study. The end result of a healed joint tuberculosis often is a synarthrosis, but there is much more alteration in the joint relations of the bones than is the case here.

Further investigation as to the etiology is in progress, and it is hoped that this preliminary study on sacroiliac joint obliteration may be followed by one in which a more definite cause can be presented to explain this unusual arthropathy.

THE VALUE OF GRANT'S PINS IN THE OPEN TREATMENT OF FRACTURES AS SEEN ROENTGENOLOGICALLY*

BY D. Y. KEITH, M.D., AND J. PAUL KEITH, M.D.

LOUISVILLE, KENTUCKY

DESCRIPTION

THE gimlet device (Fig. 1) consists of a shaft made from an ordinary wood screw 5 to 10 cm. in length and 2 to 3 mm. in diameter on which a handle is firmly fitted at right angles. The handles are 5 to 8 cm. in length and 1 to 2 cm. in breadth.

A narrow slit in each handle allows of secure locking together by a screw and tap. The screws are placed 3 to 4 cm. from the line of fracture, one screw to each fragment.

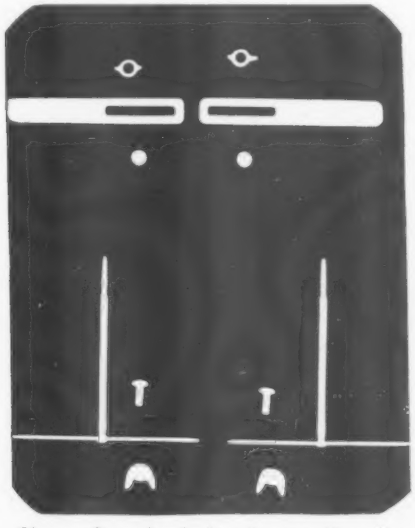

FIG. 1. Shows Grant's gimlets in two directions, showing screws and slots in which they fasten.

The handles are then overlapped and firmly locked with the screw and tap. The gimlets are made in several sizes, to accommodate the smallest forearm or the largest femur.

HISTORY

Grant's gimlets were first used by the late Dr. H. H. Grant in 1915, and a report of 8 cases so treated was made in 1917, in which he obtained good results. Since then, several scores of cases have been treated in our local hospitals by numerous operators, some of whom do very little surgery.

Practical Surgical Points. The most important point is that the screws should go through the medullary canal and enter the opposite side of the shaft. Another point is to have the screws made of better metal than an ordinary wood screw; otherwise, the tip of the screw may break off in the bone. The juncture of the screw shaft to the handle should be heavy, forming a square shoulder to prevent rocking of the gimlets. The drill-holes should be of the same size as the gimlets.

In all the cases which we have seen, the reductions have been very good, the approximation perfect in many of them, though it was the operator's first use of gimlets. If the reduction is so good in inexperienced hands, it must be very easy to do. In the hands of a real general surgeon, the approximation has been excellent. To our knowledge, no amputation has been necessary, following the use of the gimlets.

This, we believe, is a better record than has been achieved with the use of Lane's plates or any other open operation. Had any of you observed the many perfect reductions we have seen in badly displaced fractures, some of them compound, with restored function free from infections, we believe you would feel it your duty to suggest a trial of this method to your surgeons in your next case in which they have failed by traction, manipulation, etc., under general anesthesia, to reduce a displaced fracture of some of the larger long bones.

In the young or muscular individual, fractures of the surgical neck of the humerus, and transverse fractures in the middle portion of the humerus where there is marked displacement prove irreducible by the closed method. You have all seen these cases return two or three times for re-examination, with increase in the overlapping or displacement and sometimes both, after much time had been spent

* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922.

under anesthesia in attempt at reduction. All experienced surgeons and roentgenologists recognize the impossibility of satisfactory reduction in these cases by the closed method, but invariably recommend at least one attempt under anesthesia.

All of you recognize as irreducible by any closed method, transverse fractures of the femur at the junction of the upper and the middle thirds, in the central portion of the bone, or a few inches above the knee-joint when there is a few centimeters' separation of the fragments by intervening muscle and fascia. Many of these cases have such a thick piece of

FIG. 2. Fracture of the surgical neck of the humerus, with axillary displacement of the upper end of the lower fragment and rotation of the head.

muscle and fascia interposing that it is impossible to obtain true crepitus.

This is the type of fracture in which we see non-union or delayed union, as it is impossible for callous union of the fragments to occur until there has been a perforation of the impinged muscle and fascia. We feel that, in this type of fracture, our responsibility in interpretation is to insist upon an open gimlet operation as the safer and surer method, involving very much less trauma to the impinged soft tissue. Trauma means devitalized tissue, which invites infection.

We have seen but one or two closed reductions in the true transverse type of fracture of the femur in any of the above locations. One of these showed on the roentgen film a perfect reduction, made after the application of plaster of Paris, that later slipped, giving a poor result, with much chagrin to the attending surgeon. The efficiency in maintaining fixation is one of the gimlet's great assets. We all know how very little force it requires to hold a fracture in alignment, in any open method, yet how a little movement can easily displace it.

Roentgenologically, we can recognize the fractures in the central portion of the humerus, femur, etc., in which the soft

FIG. 3. Buck's extension with the arm at right angles to the shoulder.

structure between the fragments prevents reduction by any closed method. If we have an ideal, or at least, a satisfactory open method that can be conscientiously recommended, may we not insist upon its application? As roentgenologists we can serve many more people than several surgeons, as our opportunity for seeing a great number of fractures surpasses that of any surgeon.

It has been our good fortune to assist in a great number of gimlet operations, to see the real conditions present and the ease with which they are secured after reduction has been accomplished, as well as their efficiency in maintaining reduction.

It is needless to say, rigid aseptic technique is required as in any bone surgery. When this has been obtained we have yet to see an infection occur follow-

ing the use of the gimlets in simple fractures.

In many of the compound fractures where an early operation was done, infection has not appeared. The removal of blood-clots and devitalized tissue prevents infection, and the screws certainly promote drainage.

FIG. 4. Third attempt with Buck's extension with arm upward.

Two case reports with slides will suffice to show the advantages of the method, as well as the fruitless attempts at reduction of certain fractures by the closed method.

Case I. Male, aged thirty-two. Received a fracture of the surgical neck of the humerus when his automobile was overturned. A diagnosis of dislocation of the shoulder was made and reduction performed and verified by fluoroscopic examination by a near by mining-camp surgeon. Not being thoroughly satisfied, the patient came to us ten days after the injury and, on roentgen stereoscopic film examination, we found a transverse fracture of the surgical neck of the left humerus with displacement of the upper end of the lower fragment upward and inward to the axilla. The upper fragment was rotated outward and upward (Fig. 2).

Reduction was attempted by using a Buck's extension first in a downward and outward direction (Fig. 3) then in an outward direction nearly at right angles to the shoulder-joint (Fig. 4). The third attempt was upward, the arm being extended (Fig. 5). At each attempt at reduction the position of the fragments was not improved, but showed greater angulation as well as overlapping.

FIG. 5. Perfect reduction with Grant's gimlets *in situ*.

An open operation was performed three weeks after injury by Drs. E. S. Allen and W. E. Fallis, and it was difficult to separate the fragments on account of so much callus. Reduction was finally obtained and maintained by gimlets (Fig. 6).

FIG. 6. Final result. Note the moderate amount of callus and very little bone atrophy.

Nearly complete function was present in two months' time with all the movement of the shoulder-joint except extreme extension. Roentgenograms since then (Fig. 7) show very little bone atrophy or change in the periosteum at the site of the gimlet

FIG. 7. Transverse fracture of the femur. Central portion after three attempts at reduction by closed method with and without anesthesia.

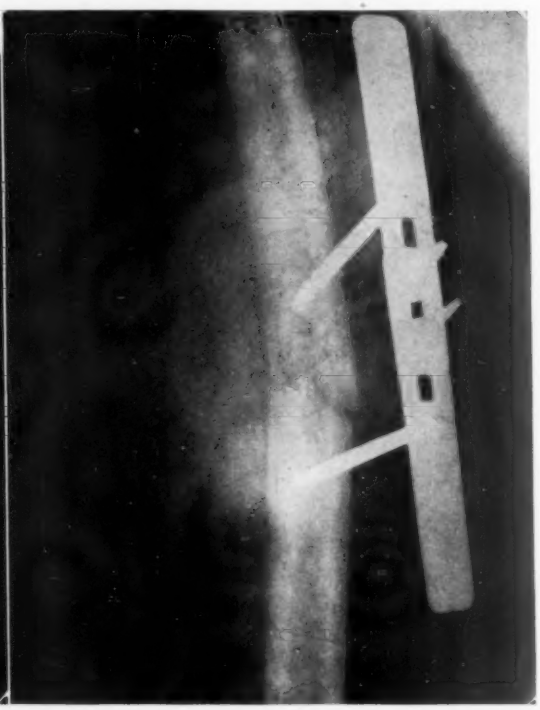

FIG. 8. Same as Figure 7 after fixation with Grant's gimlets by open method.

FIG. 9. Shows double transverse oblique compound fracture of the femur, received by a kick from a horse.

FIG. 10. Same as Figure 9 after reduction with Grant's gimlets, and with rubber tubes inserted for drainage.

FIG. 11. Shows transverse oblique fracture of both bones of the leg with marked displacement.

FIG. 12. Same as Figure 11 after fixation with Grant's gimlets.

implantation. The patient has complete restoration of function.

Case II. Male, aged seventeen. Received a transverse fracture of the right femur at the middle and upper third with displacement, 2 in. overlapping, and angulation at the site of the fracture. The first reduction was attempted under general anesthesia, using a Hawley table. The second attempt was with a Buck's extension with roentgen-ray examination in bed. The third attempt was with the leg in a double inclined plane with Buck's extension; displacement, angulation and overriding were not improved (Fig. 8).

Perfect reduction was obtained and maintained by the open method and the use of Grant's gimlets (Fig. 9).

The chief advantages of this method of open operation are:

1. The ease of application; the line of fracture need not be touched.

2. So little manipulation is required that the possibilities of infection are greatly reduced.

3. The gimlets are an aid in, and are efficient in maintaining, reduction.

4. External control of internal conditions.

5. Ease of removal; no anesthetic required.

6. No trauma in removal, with freedom from infection.

FIG. 13. Shows forearm five years after fixation with Grant's gimlets for a transverse fracture of both bones of the forearm.

7. Can be used early in compound fractures.

DISCUSSION

Dr. Davis. I would like to know if Dr. Keith puts extension on when these pins are put in; and if you can get enough extension to bring the bone ends together, why is it necessary then to put the pins in?

It has been my observation where we have put pins in, for example, through the os calcis and fractures low down in the tibia and fibula, it is not infrequent to get infection. We do get infections, and if we can get enough extension down on the long bones, would it not be well to keep it there with the extension rather than put in a foreign body? I would like to know if Dr. Keith has had any difficulty or complications.

I have had occasion to see quite a few fractures and my experience is that the more operative bone work I do the greater the number of complications. I would like to know how Dr. Keith gets the lower end of the femur back into place when he puts these pins in. It seems to me that if we could get the fracture into position by extension and put the patient in a modified Thomas splint, that it would hold it there without pins. I would like to know if he has had any complications in regard to the use of pins.

Dr. LeWald. Dr. Keith talked this over with me and I was interested in the subject.

In the use of the Steinman pin or traction by means of tongs, the danger of a bone operation is much less because it is a simple incision through the skin, and in my experience I have seen results just as good as from this method Dr. Keith has illustrated. As seen in his illustrations in the upper extremity where one cannot use this tong method to advantage, I think the results as shown are certainly very remarkable, and the method must have its use in that type of case, but I think that in the lower extremity regions a more simple pin or tong application is sufficient.

Dr. Childs. In the very extensive field that is occupied now by *x*-ray diagnosis, it seems to me that the field of fractures has been somewhat overlooked in its importance as Dr. Keith has mentioned.

I am not familiar with the Grant pins but have had an opportunity to examine by the *x*-ray the end results obtained in fractures after their reduction by the Freeman modification of the Parkhill clamp.

This modified clamp works on somewhat the same principle as the Grant pins, and can be used for the reduction of the fracture by the open method under direct inspection as described by Doctor Keith. In certain cases the fracture is not exposed, as a small incision above the fracture permits one screw to be inserted into the bone and through a similar incision below the fracture another screw is inserted, and when the clamp is attached to these screws sufficient extension can be obtained to adjust the fracture into satisfactory alignment.

I think Dr. Keith is entitled to the thanks of this society for calling our attention to the efficiency of the Grant pins in the reduction of fractures requiring an open operation.

Dr. Keith (closing). The type of fracture in which this method is indicated is the case that has been manipulated two or three times and is still in the same shape or in worse shape than before manipulaiton was started. The type of fracture we show has been, in our experience, irreducible. Why not as roentgenologists recognize irreducible fractures and save the patient two or three anesthetics and much trauma?

We have seen several cases treated by the tong method and but few if any are infected. There isn't much danger of infection in the tong or Grant's gimlet operation if you have a real surgeon who knows bone technique.

THE EFFECT OF SMALL DOSES OF ROENTGEN RAYS IN CERTAIN FORMS OF IMPAIRED HEARING*

BY D. C. JARVIS, M.D.

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DURING the summer of 1921, a patient about forty years of age was treated by means of the roentgen rays for an enlarged lingual tonsil by Witherbee's technique, namely, a 7-inch gap, 5 ma., 10-inch distance, but using two minutes' treatment time, as it was the first treatment. The rays were filtered through 3 mm. of aluminum. By means of lead foil, other areas were blocked off except that overlying the lingual tonsil. One week later, the patient reported at the office, and volunteered the information that the right ear, which had been "stuffy" for ten years, was clear, and that hearing was improved. No great importance was attached to the statement, but one month later, having a patient who had appeared at varying intervals at the office for inflation of both ears by means of the Eustachian catheter, and not succeeding readily in restoring the hearing by means of the usual inflations, a trial of the roentgen rays was suggested, the area exposed for treatment being that recommended by Witherbee in treating tonsils. His technique with a two-minute treatment time was used, exposure being made from each side of the throat as if both tonsils were being treated. Two days later, the patient, who was the proprietor of a small general store in an adjoining town, returned to the office stating that his hearing was restored, the sensation of stuffiness in his ears was relieved, and that he experienced no difficulty in hearing while waiting on customers. From this statement, interest was aroused in this subject. Outside of the use of roentgen rays, my practice is limited to eye, ear, nose and throat; hence any agent that would improve hearing commanded my attention. As cases were treated, it became apparent that all patients complaining of impaired hearing were not improved. It was soon realized that the treatment was applicable only to certain types of patients, and an effort was made to discover the type of patient in whom the use of the roentgen rays would produce results.

There seem to be three classes of individuals complaining of impaired hearing. The first class includes children and young adults whose impaired hearing is so often explained by the presence of a mass of adenoid tissue in the nasopharynx. The second class includes individuals between the ages of twenty-five and fifty, who seem to be subject to frequent head colds, complain of a more or less constant catarrhal discharge from the throat, and at frequent intervals a stuffiness in the ears with an accompanying impairment of hearing. This type of patient appears at one's office at varying intervals for ear inflations, and often emphasizes the annoyance occasioned by head noises. The third class includes those who are advanced in years, and whose outstanding symptom seems to be impaired hearing with or without the accompanying head noises, less emphasis being placed on the throat symptoms. As one considers these three classes, the outstanding feature of the first is obstruction to nasal respiration, of the second, the throat symptoms, and of the third, simply impaired hearing. As observations were continued, it was noticed that the type of patient represented by class two, that is, the individual in whom the throat symptoms were usually a prominent part of the clinical picture, responded best to the use of the roentgen rays. A study of these individuals disclosed the fact that the inferior and middle turbinates were often increased in size, that there were present lymphoid nodules on the posterior pharyngeal wall, and often a prominent band of lymphoid tissue running up either side of the pharynx just posterior to the posterior tonsillar pillar. A study of the lymphoid tissue present in the throat following the use of the roentgen rays showed that in forty-eight hours it markedly decreased in size and redness, and with it the catarrhal discharge from the throat. It was concluded that the results obtained were due to the effect of the roentgen rays on lymphoid tissue. In one patient who was timid about the use of the roentgen rays an exposure of thirty seconds was given,

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producing the same results as with the two-minute exposure. As a result of this experience, various exposure periods were tried out, and at present one minute is being used. It hardly seems possible that lymphoid tissue can be influenced by a treatment of such short duration. The work of Witherbee, in which he and his colleagues report the results of bacterial studies, and the recent work by Hickey on diphtheria carriers cause one to lean towards the theory of the germicidal effect of small doses of the roentgen rays. For some time we have been familiar with the effect on the ears and throat of the cleaning up of a bad dental condition, and also the improvement in hearing following the removal of septic tonsils. In these two instances we have believed we removed the source of infection.

There is another effect of the use of small doses of the roentgen rays, and that is its effect on head noises. In the type of patient represented by class two, the treatments so far have not failed to give relief, and if no other results than the relief of tinnitus aurium were accomplished, the employment of the roentgen rays would be well worth while. Where head noises occur in the elderly type of patient represented by class three, their relief does not seem to be so often accomplished. I am unable to explain why, except that the throat element of the case is not so prominent. In the recent questionnaire sent out by the president elect, asking, among other questions, for information on the treatment of deafness by means of the roentgen rays, suggestion was made that the effect of the rays was on one of the endocrine glands. It almost seems as if the work of Witherbee and Hickey, plus the blocking off of the gland area by lead foil and the use of a treatment cone, pointed to an effect on the bacterial content of the throat rather than on the gland. In closing, one case will be reported, as illustrating what may be expected from the use of small doses of roentgen rays in aural disease.

Female, aged forty-four. The office record shows that the patient has been coming for ear inflations at frequent intervals since December, 1912. At this time, she stated that hearing had been impaired in the right ear for fifteen years, and that the left ear developed impaired hearing a few weeks previous to her first visit. As the dates of office visits are scanned, it is noticed that springtime represents the time of most frequent inflations of ears. This year (1922) she appeared at the office in February for a course of ear inflations, and the use of the roentgen rays was suggested. Four treatments were given: on Monday and Wednesday of the first week, and on Monday and Friday of the second week, the time being one minute for each side. Head noises, catarrhal discharge from the throat and stuffiness in ears were relieved. On May 18, 1922, the patient came to the office stating that she was just getting over a head cold and wished the roentgen rays used to stop the buzzing in her ears. At this visit she stated that no head colds had appeared since February until the present one in May, that now she was not bothered by drafts, and the head noises had been absent until the present buzzing appeared following the present head cold. Since February, she has been able to hear conversation much better, could hear the alarm clock tick as she moved about the room, and was able to hear the telephone ring. On May 18th, she was treated with the roentgen rays. On May 20th, she reported that the buzzing in her ears stopped one hour after the use of the roentgen rays and that hearing improved. She has been under my constant supervision since December, 1912, during which time she has had many inflation treatments by means of Eustachian catheter, but at no time, she states, has she been free from buzzing, sound of whistles or escaping steam, until the roentgen rays were used; and the office record bears out her statement.

SUMMARY

1. Small doses of roentgen rays are a valuable aid in treating aural disease.

2. They are most valuable in cases disclosing a prominent throat element.

3. It would seem that results are obtained by the roentgen rays influencing the bacterial content of the throat.

4. Their influence is most marked on tinnitus aurium, relief following soon after the treatment.

TREATMENT OF DEFECTIVE HEARING BY SMALL DOSES OF X-RAYS

BY JOHN McCOY, M.D.

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The writer wishes to report the result of a series of cases of deficient hearing treated by the method proposed by Dr. Charles Stokes for the alleviation of this condition. The types of cases treated were embraced under the pathological conditions causing deficient hearing as follows:

Otitis Media Catarrhalis Chronica (O.M.C.C.) otherwise known as chronic dry catarrh.

Otitis Media Purulenta Chronica (O.M.P.C.).

Otitis Media Purulenta Residua (O.M.P. Residua).

Otosclerosis.

The majority of cases had had all foci of chronic infection removed, and had been placed on the other well-known methods of treatment before being subjected to the *x*-rays.

The method is employed as follows: The patient is seated 30 inches from the target and has the *x*-rays applied in turn to the regions of the right ear, left ear, the occiput and the open mouth in a direction toward the pituitary gland. A 110-volt current is used with a 4-inch spark-gap and from 5 to 10 ma. The exposure lasts from ten to thirty seconds laterally, from ten to twenty seconds posteriorly and from five to fifteen seconds anteriorly. An opaque shield with a perforation 3 inches in diameter is used laterally. The shield is held in front of the eyes for the anterior exposure. The treatments are given two or three times weekly for three to six weeks.

The cases were tested by the watch, acoumeter, voice and whisper, before and after the treatments. The patency of the Eustachian tubes was also specially noted along with the other usual notations of the condition of the nose, throat and ear. The results noted were placed in the following categories: Greatly improved, slightly improved, no improvement.

By "greatly improved," we mean a greater sensitization to the human voice and whisper, so that the patients were able to hear from five to six times further than before treatment; the improvement to the finer sounds of the watch, while slight, was mostly negligible.

By "slightly improved," we mean the patient was able to hear two to three times further than before testing.

A list is given of 45 cases treated, with the corresponding results:

O.M.C.C.	Greatly improved	9
	Slightly improved	19
	No improvement	7
O.M.P.C.	Greatly improved	0
	Slightly improved	2
	No improvement	0
O.M.P. Residua	Greatly improved	1
	Slightly improved	1
	No improvement	0
Otosclerosis	Greatly improved	2
	Slightly improved	2
	No improvement	2
	Total	45

In addition to the above, there was noted a decidedly greater patency to the Eustachian tubes in all cases in which there was a tendency to stenosis. In 2 cases, there was noted a decided improvement in the sense of smell. In 2 cases of hypertension there was noted a decided drop in blood-pressure. Tinnitus, which was present in most of the cases, was stopped in 6 and alleviated in 10 cases.

In conclusion, the writer believes that we have here a method which is still empirical, is not harmful and is in many cases beneficial. As to the theory of its action, the writer feels that there must be an absorption of small-celled infiltration in the Eustachian tubes and possibly at the terminals of the auditory nerve, as well as perhaps a stimulation of the same. Whether there is penetration to the pituitary gland is a question, but that some change takes place in it, is given food for thought by the alteration in blood pressure.

* Read by title at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922. Discussion of this paper and the others in the same symposium will appear in a subsequent number of the JOURNAL.

THE ROLE OF RADIUM NEEDLES IN THE TREATMENT OF NEOPLASTIC DISEASES*

BY WILLIAM L. CLARK, M.D.

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THOSE who have employed radium with due regard to established facts concerning the physics of the element, and who, by the study of authentic literature and sufficient clinical experience, have acquired a knowledge of applying it correctly, are profoundly impressed with its power for good in the treatment of malignant disease, and certain other pathological conditions.

While great strides have been made in an incredibly short period of time, toward increasing the sum total of knowledge concerning the physical properties of radium and the problem of its application to disease, we are not only justified in the belief that there is much yet to be learned concerning it, but that, with continued intensive study, laboratory experiment and clinical experience, radium will soon be shown to possess infinitely greater value as a therapeutic agent than is realized at the present time.

There are numerous ways and forms in which radium may be employed to meet the individual requirements of a case, and the ingenuity of those employing this agent is often taxed to the utmost to devise means by which particular indications may be met to the greatest advantage. Indeed, it is absolutely essential that this flexibility of application be recognized and practiced, with careful consideration of individual requirements, if the best results are to be obtained. A highly specialized instrument in the hands of one unaccustomed to or unskilled in its use might bring discredit upon the instrument and upon himself, while in the hands of an experienced and skilled workman the same instrument might be made to serve its purpose to the utmost of its possibilities, and establish the reputation both of the instrument and of the operator.

So, also, the reputation of radium has often suffered, not for lack of potential value, but by its unskilled use.

The therapist must, also, with broad vision, recognize the importance of other measures, such as operative surgery, electrothermic methods, and the *x*-rays, else he will not enjoy the same satisfaction of achievement as does he who recognizes and practices combined methods of attack.

One who, by writings and practice, makes pretension of treating malignant disease successfully, must acknowledge the importance of all units which have been shown, by critical tests, to be of value, else he will in time lose the confidence of his clientele and be outdistanced in achievement by the man who does his duty to his patients, to the medical profession, and to himself, by utilizing every means available to accomplish the desired results.

Of these means, not the least in value is the application of radium in needles, and it is to the consideration of this method that the present paper will be confined.

The introduction of radium needles marked an epoch in the usefulness of radium therapy, not only in the treatment of some forms of malignant disease in certain anatomical locations, but also, in some benign neoplastic conditions.

Over three years of study and varied clinical experience with radium needles have led me to the recognition of the following facts concerning this form of radium application:

When radium needles are introduced into neoplastic tissue the maximum reaction is obtained, owing, in the first place, to the direct action of the rays upon the tissue, and in the second place, to the cross-fire effect from needle to needle.

The total radiation from each needle can be utilized locally, in contradistinction to the extravagant dissemination in the air of approximately three-fourths of the radioactivity during surface application.

The corrosive action of the body fluids on the steel needles as originally provided, has been largely overcome by the use of

* Read at the Seventh Annual Meeting of THE AMERICAN RADIUM SOCIETY, St. Louis, Mo., MAY 22–23, 1922.

nickel alloy. In some cases, however, platinum or irido-platinum needles are more desirable, although these are less durable, and bend more easily. In addition to the strength of the metal employed in the composition of such needles, an important factor is its property of filtering out the beta rays, or all but the hardest beta rays, depending upon the thickness and density of the metal employed. The fact that some of the beta rays are filtered out by the needle walls has been found to be of advantage, since the same therapeutic result can be obtained without as great an inflammatory reaction and after-discomfort to the patient as when all the beta rays are employed. Also, there is less danger of subsequent formation of undesirable sloughs.

By the use of radium in needles, and the judicious consideration of this property of filtration, a dose can be given which will exert a lethal action upon malignant cells without causing necrosis with sloughing, but rather, a retrogression of the growth and relative conservation of the normal cellular elements. The general appearance is that of mummification, rather than the usual necrotic changes.

A small quantity of radium, from 1 mgm. to 10 mgm. in each needle, can be used to even greater advantage than a larger quantity, for the reason that this greater concentration will be more likely to produce sloughing, while the desired effect is to change the character of the cells and render them innocuous by atrophy, also secure final replacement by fibrous connective tissue.

Small quantities of radium in needles inserted at equidistant points throughout a growth, will, by cross-fire action, result in homogeneous radiation over a wide area, while a single capsule or needle containing a large quantity of radium, whether buried in the growth or applied to the surface, will exert its greatest influence at the point of contact, its effect growing rapidly less potent as the distance from the radium is increased.

Dosage is all-important in radium-needle application and is most difficult to estimate. Important points to be considered are: the anatomical location of the neoplasm, its type and its grade of malignancy. For example: the uterus will stand a larger radium dosage than the rectum; the breast, than the buccal surface, the tongue, the floor of the mouth or the tonsils; the stomach, more than the intestines, etc. The requirements of the individual case must, also, be studied. A correct technique is, therefore, of the utmost importance. With good judgment and such technique, most gratifying results will often be obtained; but should mistakes be made in any of these several factors, much damage and suffering may result. For example, too small a dose may only stimulate the neoplasm, while an overdose may result in such dense fibrosis that circulation in the mass is totally arrested. Then, within a few weeks or months, sloughing will occur, resulting in an ulcer, which will not heal. This condition is as bad, though benign, as was originally present.

Radium needles should be used very guardedly near bone, since experience has taught that the vitality of normal bone is easily impaired. As a result of such damage a sequestrum will often form, necessitating surgical removal; or, a fibrous periostitis has been known to occur, and the resulting pain has been so great and persistent that opiates were called for in increasing quantities.

Radium needles attached to strong braided silk thread may, after careful sterilization, be inserted into some of the abdominal viscera immediately following a laparotomy.

It has been my clinical experience that needles containing 10 mgm. of radium should not be inserted into a malignant growth at a distance greater than 25 mm. apart, as a lethal effect, from this standpoint, will not be produced beyond this distance. In some instances the distance should be even less, depending upon the degree of radiation concentration desired, the exact amount of radium in each needle, and also, the time allotted for the treatment.

Needles with cutting trochar points have been found to be more generally useful than those with round tapering points. A trochar is used before the insertion of a needle if the tissue is dense, but if

of soft consistency, the needle may be inserted directly into the tissue.

Where concentrated action of radium is desired, radium needles may be grouped together and used in a metallic container, with proper filtration. Or they may be placed side by side in a flat metallic container for surface work.

An efficient radium needle equipment consists of very small irido-platinum needles containing as little as 1 mgm. of radium, platinum, irido-platinum or steel alloy needles, containing 5 and 8 mgm. respectively, and steel alloy needles containing 10 mgm. Some of these needles should be of the "combination" type, so that either a thread or a screw-shank may be attached for superficial or deep work, respectively. Needles may, of course, contain larger quantities of radium than 10 mgm., but I have found this a convenient unit with which to work and to meet all requirements.

The very small platinum needle containing 1 mgm. of radium is indicated in the same conditions as is the glass radium emanation "seed," and has the advantage that it may be withdrawn after sufficient radium dosage has been given; whereas, the glass "seed" remains in the tissue, where, though it later becomes incapsulated, it may still be considered a foreign body.

Capillary tubes containing radium emanation may be inserted into needles and used with satisfaction. Many radiologists, however, who have a choice of needles containing the element or emanation, prefer the former, owing to the greater stability of the radiation given off by the element.

When a malignant or other growth has received a maximum radiation dose with needles, it is inadvisable to employ them again, should the same tissue need further treatment, as there is a tendency for such tissue to break down under these conditions. Radiation treatment, either with radium or the *x*-rays, may, however, be carefully given from the surface, at subsequent periods, without great danger of such a sequence.

The secondary radiation from metal in contact with the tissues beneath the surface does not produce such an acute reaction as does contact of the metal upon the skin surface.

The patient should be prepared as for any surgical operation, since infection may occur if the field is not sterile. The needles may be inserted, as a rule, under local anesthesia. Where, however, many needles are to be employed, or there is any other contraindication to the use of local anesthesia, such as a supersensitive or nervous patient, general anesthesia may be induced.

I do not use radium needles in localized basal-cell epitheliomata, or even in localized malignant lesions of any type, unless it be as a secondary measure, the electrodesiccation and electrocoagulation methods being much to be preferred, provided the condition is such that the disease can all be destroyed at once. When, however, the disease is not amenable to immediate eradication by electrothermic methods or surgery, or when metastasis has occurred, then radium needles alone, or in combination with other measures, may be depended upon to yield satisfactory results, in many cases.

Among the anatomical locations and conditions, malignant and otherwise, in which radium needles may be used, are: Adherent neoplasms of the cornea and bulbar conjunctiva; growths between the globe and floor of the orbit not involving the lid, in which needles could be inserted through the lid into the growth; deep seated growths of the canthi; laryngeal growths in which small needles could be inserted between the membrane and the cartilage; growths of the tonsils, pharynx, soft palate, buccal surface, tongue, and floor of the mouth, anterior and posterior nares, and the esophagus; metastatic cervical and other glands; inoperable cancer of the breast; cancer of the pyloris and other parts of the stomach (after laparotomy and gastroenterostomy); cancer in some other of the abdominal viscera, and of the bladder through a suprapubic opening, or per urethra; cancer of the uterus involving outlying regions impossible of access by capsule, but which, if impossible to reach entirely from below, can be reached from above through an

abdominal incision; neoplasms of the urethra and rectum; cancer or hypertrophy of the prostate by suprapubic, perineal or rectal route; large cavernous angiomata; exopthalmic goiter.

There is much more to be said relative to the value and technique of radium needle application, but to discuss the subject further would be to exceed the scope of a single paper.

In conclusion, it may be asserted with assurance that radium needles fulfill an entirely unique place in our equipment and have aided very materially in the fight against neoplastic diseases.

DISCUSSION

DR. KIRKENDALL. Over a year ago I commenced to boil radium needles. Since then I have had two interesting experiences: in one instance, the needle broke directly through its center, making a hinge joint, with the raw radium visible, and in the other, the eye pulled out. Both needles were sent back to the factory for replacement. There was no loss of radium in either needle. Dr. Clark did not mention how he sterilizes his needles, but I have found it satisfactory to boil them.

In treating a malignant growth directly under the skin, if you wish to needle the growth, the needles will stay in better if the eye of the needle is pushed clear below the skin level.

I believe that the superficial malignancies of the skin are best treated with a surface pack of radium.

When a malignant growth is deep-seated and in an area of the body where the growth is near the superficial lymphatics, or where the part is drained by many lymphatics, as in a case of cancer of the breast, I think the growth proper should be needled first (buried radium needles) and all the surrounding areas treated afterwards with a surface radium pack, in order to catch any malignant cells that may have been squeezed out by the application of the needles and other manipulations. If this procedure is reversed, and the outside areas are treated before the growth proper is treated, the trauma to the growth may recontaminate the outside areas, and by so doing, render the treatment useless.

I would like to report a case of buried radium needles in a woman forty-eight years old who had had two previous operations for recurrent cancer of the breast. The radical operation for removal of the breast occurred in July, 1915, with a microscopic diagnosis of adenocarcinoma. In 1920, a recurrence in the axilla was incompletely excised. The recurrence surrounded the axillary vein. Again a section was taken, with the same diagnosis. A surface radium pack was used. In July, 1921, she came back with a mass in the axilla about the size of a hickory nut. The mass was exposed and found to surround the axillary vein. It could not be removed, and five 10-mgm. needles were inserted into the mass and left *in situ* for seven hours. There was no serious reaction, the growth ceased to increase, and then shrank to the size of a bean. The pain in the arm and shoulder that she had been having gradually ceased, as did likewise the swelling in the arm. I report this case to show that we do not need to be much afraid to insert radium needles near the large blood-vessels.

DR. PANCOAST. There is, I think, a certain amount of danger from the traumatism caused by the implantation of needles in some growths as a cause of metastasis. Wherever possible, I think the preliminary surface radiation should be carried out first.

I believe in boiling needles in the sterilization process, and use the Bowen holder in doing it. One should be careful that the water does not boil away. We have had one unfortunate experience with infection following needle implantation. A man with a cavernous angioma of the soft palate had two needles implanted in the growth and within a few hours he had a very sore throat, and five days later died of pyemia. A blood culture showed hemolytic streptococcus. He, of course, had the infection in his throat at the time the needles were put in, and the infection was carried in by the needles.

DR. BOWING. I have had the same difficulty —bending or breaking of needles, as well as dislodging the eye. It has been my policy (because the metal in the needle will not retain a sharp point, and constant sharpening wears the needle back into the radium cavity) to cut the way with a small, sharp-pointed knife, just enough to get the needle in, as well as to the proper depth. I place the knife just where I want to place the needle, then withdraw it sufficiently and enter the passageway with the needle holder to deposit the needle. In this way I do not break the needle or traumatize the tissue.

I would not consider a thread as a means of withdrawing the needle. It cannot be safely sterilized. I am using a fine resistance wire which is sufficiently strong and can be properly sterilized.

The only thing I have to contend with is hemorrhage, and a little packing usually

suffices, and is held in place with adhesive strips.

Dr. Aikins. I have a great many difficulties with the needle and have been using flat applicators for thirteen years. I get much better results than with needles in surface work, and I am sure if the gentlemen will try them out they will be pleased.

Dr. Clark (closing discussion). Radium needles should be sterilized thoroughly. Failure of such precaution may result in serious local infection or even septicemia. There appears to be a wide-spread belief that boiling destroys the efficiency of the needles, but such is not the case. They may be boiled as frequently as is necessary. The next best method of sterilizing radium needles, threads and wire, is to place them in a formalin bath followed by absolute alcohol, and finally, by sterile water.

Radium needles may be inserted into soft tissue without the previous use of the trochar, but in dense tissue, the trochar, or the narrow scalpel suggested by Dr. Bowing, may be employed previous to the insertion of the needles.

As needle sutures, my preference is for heavy braided silk thread, as it is much easier to handle than the wire. Moreover, wire is easily kinked and may break when least expected.

SUPPURATIVE OSTEOMYELITIS OF THE LEFT SIDE OF THE PELVIS

BY IRWIN P. LEVI, M.D.

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THE following case is reported because of its apparent rarity and because practically all the more common textbooks on the subject of surgery fail to contain any mention of its occurrence, or the important part the roentgen ray plays in the diagnosis of this disease. Even so complete a treatise as "Keen's Surgery" contains no mention of this condition. Nor have I been able to find any mention made of it in any roentgenological journal of recent date. The only textbook in which I could find a description of this condition is the treatise on surgical diagnosis by Dr. A. B. Johnson,[1] in which work there is a page devoted to this subject, with a description of the etiology and symptoms thereof.

Etiology. Johnson states that this condition is a rare one; that the ilium is more frequently attacked than any other of the pelvic bones, and that in the lines of union of the several bones the acetabulum is the favorite seat of localization. Save for direct infection through wounds, where the infection is carried to the site of the disease, the occurrence of the infection is more frequent in childhood. While in a certain percentage of cases subcutaneous injury, often of only slight severity, may be the direct causative factor, it is difficult to say in many cases whether the injury itself had any relationship to the inflammation of the bone.

Symptomatology. Johnson gives the symptoms as similar to those of osteomyelitis elsewhere in the body, together with some special localizing symptoms. The symptoms of osteomyelitis are in general those of sepsis; fever of moderate degree, with morning or evening exacerbations or both, an increase of leucocytes, with relative increase of polymorphonuclear cells, and the general picture of an intense poisoning of the body by infection. With this picture one may find localized tenderness, pain and swelling of the involved parts, and, after a week or two, if the patient survive that length of time, the signs and symptoms of a deep-seated suppuration will become evident. If the acetabulum is involved, the picture may resemble an acute inflammation of the hip joint. In general, these are the symptoms given of this condition, and, to quote Johnson again, "The picture is often one of an intense and rapidly fatal sepsis, in the face of which surgery finds itself quite helpless."

Female, aged fifteen, white, height 5 ft. 6 in., weight approximately 85 lbs.

Past History. Patient has had mumps, measles and whooping-cough. No scarlet

fever, or any other serious illness. No history of pulmonary disease, save an acute attack of influenza two years ago, moderate in severity and lasting ten days.

Family History. Mother living and well. No history of miscarriages. Father died of pneumonia. Two sisters and one brother living and well. Hygienic conditions of residence normal.

Present Illness. On June 25, 1921, patient began to complain of pain in left buttock and inability to use the leg to any great extent. This condition rapidly grew worse; on June 27th the patient was not able to use the limb at all. She was then put to bed; temperature 105° F.

Osteitis of left side of pelvis.

Shortly afterward she became delirious, but during the entire delirium did not attempt to use either lower extremity or to move herself about in bed, but tossed her head from side to side and attempted to rise on her right elbow.

The blood was examined for malaria and for typhoid fever—both tests negative. The tentative diagnoses were ptomaine poisoning and peritonitis, probably due to a ruptured appendix. The abdomen was markedly distended and rigid, and very painful to palpation. During this time she expectorated a moderate amount of blood.

At the end of ten days the temperature fell to 100°F. in the morning with evening rises to 103°, and the delirium subsided. The abdomen became less tender and the distention lessened. About this time, there was swelling over the external condyle of the right elbow, which was tender and red and the presence of fluid was suspected. Under local anesthesia an incision was made and pus obtained. The wound healed rapidly. During the next fortnight it was noticed that the left thigh became larger than the right. The thigh was opened under local anesthesia, the opening being about 3 to 4 inches below the greater trochanter of the femur. Foul yellow pus was found. Immediately the temperature dropped to normal.

Roentgen-ray Examination (September 1, 1921). Evidence of a former periostitis in the region of the right elbow-joint, limited to the humerus. Periosteal increase over the internal and especially over the external supracondylar portion of the humerus. The structure of the bone appears normal; no evidence of active infection demonstrable. No involvement of the upper portions of the radius and ulna. The films of the pelvis show evidence of a marked suppurative process involving practically the entire left side. The left side of the sacrum at, and in close proximity to, the sacroiliac synchondrosis is involved, with entire loss of detail of line of articulation. The entire iliac bone is involved as far downward as the iliopectineal line, with two irregularly oblong areas of decreased shadow density, each measuring approximately 4 cm. in length and 2 cm. in width. The acetabular cavity, as well as the head of the femur, is not involved in this process. There is some degree of bone proliferation at the lower margin of the left sacroiliac articular line, as well as on the external surface of the iliac bone just above the acetabulum. Some roughness of outline and evidence of periosteal proliferation of the ramus of the ischium, together with a slight increase in the size of the bone. The pubic bone appears to be normal in outline. Films of the lumbar spine, made to eliminate the possibility of a psoas abscess as the underlying cause, show it to be normal with no evidence of bone infection. The infectious process seems to be limited purely to the left sacrum, iliac bone, and the ramus of the left ischium.

This case presents the following points of interest:

1. Its rarity.

2. The occurrence of the symptoms of peritoneal involvement, due probably to the leakage of the products of infection through the thin peritoneal lining of the abdominal cavity and giving rise to the symptoms of a general peritonitis. This demonstrates clearly that in a case presenting the symptoms suggestive of a general peritonitis, without localizing symptoms and without the history of a disease that would of itself indicate the lesion, such as typhoid fever, pelvic infection, etc., occurring in a child, the possibility of a pelvic osteomyelitis should not be disregarded and a roentgenological examination should be made of the entire pelvis to determine the possibility of infection. The symptoms of general peritonitis were the predominant ones in the early stage of the disease.

3. The occurrence of so extensive a process without any history of injury even of a trivial character, or without any other localizing symptoms save a disinclination to use the left leg, and yet at the same time possessing no symptoms which would localize the process to the left hip-joint, or to the limb of the side of the pelvis involved.

4. The necessity of routine roentgen-ray examination in all cases presenting symptoms suggestive of pyemia, or of hidden infection, and yet possessing no localizing symptoms, or faint ones at best. By this means and with this aid, many infections whose origin is an apparent mystery, can be definitely localized and adequately and properly treated to prevent possible death, or at least limit subsequent deformity.[1]

[1]Johnson, A. B. Surgical Diagnosis, iii, 128.

GLASS RETAINED IN THE HAND AND FOOT

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Numerous instances are recorded in which bullets and other foreign bodies have been retained in the human body for varying periods of time without apparently causing any troublesome symptoms. Such objects, as a rule, are compact and relatively small in size and have comparatively rounded outlines and smooth edges. It would seem impossible that extremely sharp-edged and pointed objects, such as splinters of glass, could be silently retained in the active, delicately constructed portions of the body, such as the hands and feet. Their complex anatomy of tendons and tendon sheaths would seem to preclude retention without immediate and greatly impaired function. Such instances as those reported in this paper would seem to be comparatively rare and illustrate what might be called the accommodative powers of the human body.

It would be of interest to know how frequently retained fragments of glass occur in the practice of individual physicians; and also how often they are detected by means of the roentgen ray. The following cases may be of sufficient interest to warrant reporting.

CASE I. (x 273). Came to the Blackwell Hospital May 17, 1918, complaining of increasing pain and disability of the left foot on attempted walking. Only a small scar was visible on the plantar surface of the foot, and no tumor or swelling was present. His personal history developed the fact that nineteen years before, when a small boy, he had stepped barefoot into a box of glass. Immediately after the injury the physician in attendance had removed several spicules of glass from the wound, after which it healed rapidly. Though he led a very active life on the farm and in the oil field, the foot had never troubled him until a few months previously. A roentgenogram showed a foreign body deep in the plantar fascia which was diagnosed as a piece of glass. On May 21, 1918, under local anesthesia, an irregular piece of glass measuring 1¼ in. by ⅝ in. was removed from beneath the deep plantar fascia.

[1] JOHNSON, A. B. Surgical Diagnosis, iii, p. 128.

Case II. (x 476). On April 16, 1918, while engaged in a friendly scuffle, the patient ran his right hand into a glass door, smashing the glass and making a small lacerated wound on the dorsum of the hand. In dressing the wound no glass was found, and the patient insisted that no roentgenogram was necessary, since he was sure it was only a superficial wound and would "soon heal." This it did promptly and without infection or pain. The patient is a chemist for a large industrial organization, using his hands actively: and not until some twenty months later did pain and impaired function develop. On January 30, 1920, he consented to a roentgen-ray examination, which disclosed a large triangular fragment of glass between the third and fourth metacarpal bones and at right angles to their axis. Even at this time, the pain and incapacity were comparatively slight, so that it was not until almost a month later that he finally submitted to operation. However, on February 24, 1920, under local anesthesia and a dorsal incision, the glass fragment was found and removed. Recovery was uneventful.

Fig. 1. Case I. Left foot, dorsal view. Glass in foot for nineteen years.

Fig. 2. Case II. Right hand, dorsal view. Glass in hand for twenty-two months.

STATISTICS AND TECHNIQUE IN THE TREATMENT OF MALIGNANT DISEASE OF THE SKIN BY RADIATION*

BY HOWARD MORROW, M.D., AND LAURENCE TAUSSIG, M.D.

SAN FRANCISCO, CALIFORNIA

THE treatment of malignant diseases of the skin was one of the first fields of usefulness noted for radium, and it has remained one of the most important as well as one of the most satisfactory. It is not within the scope of this paper to go into the voluminous and growing literature on the subject. The malignancies of the skin that we are called upon to treat are the basal-celled epitheliomata, squamous-celled epitheliomata and the various types of cutaneous sarcomata. The technique of treating these lesions with radium will be discussed, and then the statistics will be presented.

Rodent ulcer or basal-celled epithelioma is one of the most satisfactory types of malignancy to treat because of its slow course and because it does not involve the regional lymph-nodes. Its common occurrence on the face, especially about the canthi and eyelids, makes it important to produce the best possible cosmetic result. Radiotherapy has become the treatment of choice for these lesions because of the ease with which it is applied, even in difficult positions, the good cosmetic result with the production of a soft, supple, relatively small scar, and because it is painless. The technique of treating the average case is simple. A radium plaque, preferably of full strength, large enough to cover the lesion with a margin of 1 to 3 mm. may be used, screened with 0.1 mm. of aluminum and a single layer of rubber dam, for a total of two to four hours, divided between two or three days. If the lesion is very superficial, the time may be cut down to one or two hours. If the lesion is rather deep, the screening may be increased to 0.5 mm. of aluminum and the time increased to five or six hours; or one hour may be given with the lighter screen and four or five hours with the heavier screen. If tubes are used, 40 to 60 mc. hours should be given to each sq. cm. of surface of the lesion, screened with 0.5 mm. of silver and 0.5 to 1.0 mm. of rubber or its equivalent. Lesions at the nasolabial fold and behind the ear lend themselves particularly well to treatment with tubes. In treating growths about the eye, it is not necessary, as a rule, to protect the conjunctiva, as it is very resistant to radiation, the reactions which are set up clearing rapidly without causing permanent damage. Every now and then a deep nodular basal-celled epithelioma is encountered which is resistant to surface

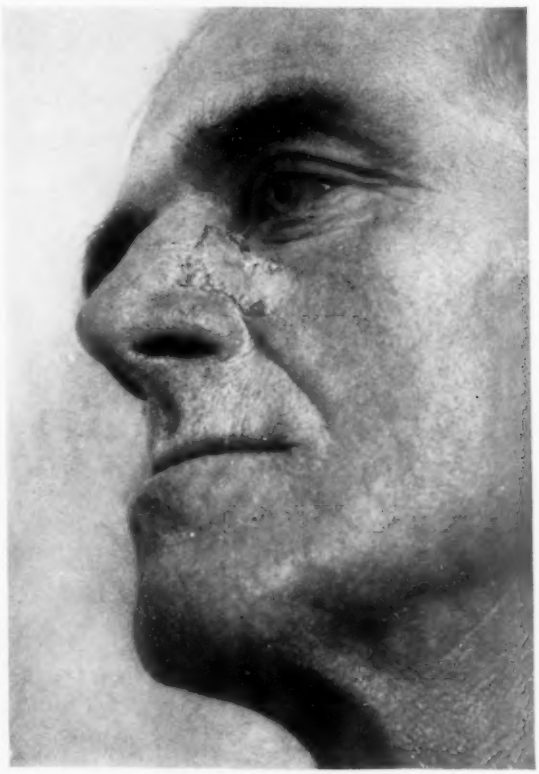

FIG. 1. Basal-celled epithelioma, cicatrizing type. Treated with radium plaques.

applications. For these, the best form of therapy is the insertion of unscreened tubes of emanation, if they are available. These tubes may be of 0.5 mc. each or less, the number depending upon the size of the nodule treated. One or two such tubes are usually sufficient. If emanation cannot be obtained, steel needles containing radium element may be inserted into the growth,

* Read at the Seventh Annual Meeting of THE AMERICAN RADIUM SOCIETY, St. Louis, Mo., May 22–23, 1922.

the time of exposure depending upon the amount of element in the needles and the size of the growth. Fortunately, we are not seeing many of the very extensive long-standing cases with great destruction of tissue, which were so common a few years ago. It is always possible to keep this type of basal-celled epithelioma under control, but it is almost impossible to produce a permanent cure in many of them. The borders of such very extensive growths should receive the most attention, as the activity is usually confined to this area. Whenever bone is involved, the prognosis must be guarded. If the bone involvement is not too extensive, a thorough raying, with the production of a severe reaction, may cause a sequestrum to form, which, when it separates, will carry with it all the remaining malignant tissue. The question of curetting the pulpy rodent tissue before radiation is still an open one. The advantages are: Lessening the time of radiation by about one-half, the exposure of the true extent of the lesion, which cannot always be accurately judged by observation and palpation, and the procuring of tissue for a microscopical examination. It is also likely that the percentage of recurrences will be less if the lesions are curetted before radiation. The chief disadvantage is that it probably increases the scarring somewhat, and this is of particular importance in lesions about the eye. In addition, curetting is apt to be rather painful. The question can only be solved by experience. It will probably develop that certain well-defined types should be curetted before radiation, while others should receive radiation only. At the present time, it is our custom to curette and immediately radiate all basal-celled epitheliomata when the nodules are large, and we believe that in all ulcerated types, radiation without curettage is all that is necessary. We are convinced that in the majority of these cases of rodent ulcers, radiation with the *x*-ray in experienced hands is capable of producing just as satisfactory results as radium, though our own experience has been limited to the latter. It is certain, however, that radiation with the *x*-ray is impracticable with lesions located in the natural fissures and about the eye.

The treatment of cornifying epitheliomata presents a much more difficult problem. Fortunately, these growths occur far less frequently than rodent ulcers. They are rapid growing, usually metastasize early,

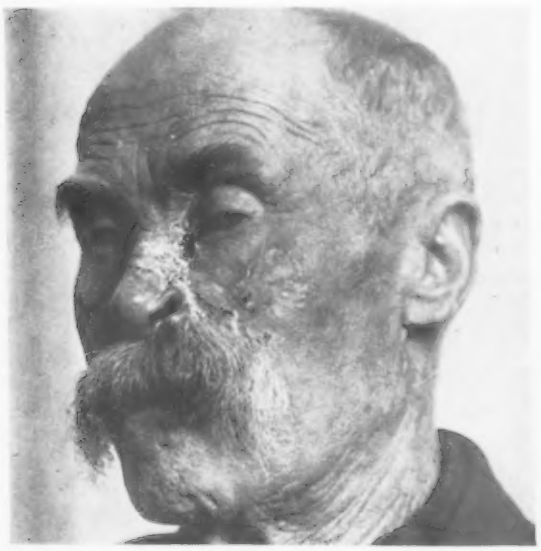

FIG. 2. Basal-celled epithelioma, cicatrizing and ulcerating type. Treated with surface applications of radium in plaques and tubes.

FIG. 3. Basal-celled epithelioma. Curetted on account of the depth of involvement and treated with radium plaques.

and may be resistant to radiotherapy. In general, two clinical types of squamous-celled epitheliomata are encountered; those in which the predominating direction of growth is exuberant, and those in which the growth is indurating. The exuberant, everting type is usually less malignant, metastasizing later and responding better to radium therapy, partly because it is more accessible. The two types merge into one another and the everting growth always eventually indurates. In all of these, radiation should be thorough, and little thought may be given to the cosmetic result. Surface radiation should be carried out as for basal-celled epitheliomata, or somewhat more intensively; and in addition, unscreened tubes of emanation should be seeded throughout the mass, using approximately one tube of 0.5 to 1.0 mc. per c.c. of tumor. When in doubt, use too much rather than too little. If emanation is not to be had, steel needles containing radium element may be effectively used. Only the most superficial and small squamous-celled epitheliomata may be treated by surface radiation alone. In addition to thorough radiation of the primary lesion, attention must be paid to the neighboring lymph-nodes. If these are not already palpably involved, they should be thoroughly rayed with the *x*-ray. If they are involved, they should first be rayed, and then removed surgically with the associated gland chain, if that is possible. If this is not possible, they should receive surface radiation, and then be seeded with bare tubes of emanation, or steel needles containing radium may be inserted. This procedure may make them operable later. In some cases, partial operation with the insertion of emanation tubes at the time of operation may be indicated. It is probable that the perfection of the technique of deep *x*-ray radiation will improve the prognosis of these cases, even to the point of making operation unnecessary. We have practically abandoned the use of the radium pack in favor of the *x*-ray in the treatment of the lymph-gland areas, because it is apparently just as efficacious and more economical.

FIG. 4. Basal-celled epithelioma. This is the type that can usually be held in check but can rarely be cured.

FIG. 5. Squamous-celled epithelioma of the ear. Treated by the insertion of bare tubes of emanation and surface applications of radium.

Epitheliomata of the ear present a special problem. They are often of the squamous-celled type, but are usually less malignant than this type of growth elsewhere on the glabrous skin. Nevertheless they are often resistant to radiotherapy, and adequate doses to lesions in which the cartilage is involved produce painful and slow-healing

FIG. 6. Squamous-celled epithelioma of the ear simulating a basal-celled epithelioma. Curetted and treated with radium plaques.

reactions. The smaller lesions may properly be treated with radium alone, but those of more than 1 cm. diameter should be thoroughly curetted, cauterized, preferably with pure chromic acid or the actual cautery, and then rayed cautiously. In epithelioma of the ear, the local lymph-nodes need not be rayed unless the lesion is very extensive, but they should be carefully watched. Of course, palpable involvement should be looked for, and if present, should be treated as indicated above. *X*-ray therapy of squamous-celled epithelioma of the skin has not been very satisfactory as yet.

Sarcoma cutis is much less common than either of the types of epithelioma of the skin. These sarcomata vary greatly in their susceptibility to radiotherapy and in their grade of malignancy. They are inclined to be very malignant, and should be treated in accordance with the principles laid down for the treatment of squamous-celled epitheliomata. The local lesion of myxofibrosarcoma responds rapidly to radium, but distant metastases occur sooner or later. Very small fibrosarcomata

FIG. 7. Squamous-celled epithelioma of the ear. Resisted radium therapy alone and was curetted and cauterized with chromic acid crystals, following which radium was applied.

may be curetted and then radiated intensively with good results. The so-called melanosarcoma is exceedingly resistant to radiotherapy. The more pigment present, the more resistant the lesion is. Usually the individual lesions do not respond at all to therapy, and even if they do, distant metastases are the rule. Many of the reported cures of melanosarcoma

are probably errors in diagnosis, and the lesions which were treated were fibrous nevi with increasing pigmentation.

In Table I, we have divided the cases of basal-celled epithelioma into three classes. The first, which is by far the most common, is the small superficial type of lesion. This occurs, for the most part, in cases which could be cured readily by a number of other methods, but in which radiotherapy is chosen as producing the best cosmetic result. The second division includes the more extensive lesions which have not, however, involved the deeper structures. The third class includes those in which

FIG. 8. Squamous-celled epithelioma of the face. Treated by insertion of bare tubes plus intensive surface applications.

cartilage or bone was involved, or those in which the growth extended down into the orbit. A fairly large number of lesions were curetted before being radiated. Those classified as clinically cured were not, in all cases, cleared by a single course of radiation. Quite a number of them recurred after insufficient treatment and were retreated. They reacted as satisfactorily to radiation as before in every case. Those classified as still under treatment have been stubborn, and have been treated repeatedly, but they are lesions that we still expect to cure, often with the aid of curettage. Those recently treated have not been included in this table. The failures are patients who have passed out of our hands, or have died while still showing evidence of the disease.

Table II shows the number of squamous-celled epitheliomata which we have treated during the past three years, indicating the number of cases which have responded well primarily, and those which were failures. The time is too short to consider

FIG. 9. Squamous-celled epithelioma of the face. Intensive surface applications of radium were used in this case.

any of them as cured. The lesions have been divided into those of the ear and those of other portions of the glabrous skin. Lip cancers have been purposely omitted as not coming within the scope of this paper. The lesions classified as still under treatment are lesions which have cleared satisfactorily, but which have not as yet been clear for six months.

Table III indicates the number of sarcomata of the skin that we have attempted to cope with. We have declined to treat a number of melanosarcomas, having found the lack of efficacy of radiotherapy in these cases. The two small fibrosarcomata which we have apparently cleared, were each less than 1 cm. in

diameter, and both of them were curetted before applying radium. The larger lesions cleared apparently for a time and then got out of hand.

Our experience has convinced us that radium therapy, combined in appropriate cases with other methods, is the most satisfactory for cutaneous malignancies.

TABLE I

BASAL-CELLED EPITHELIOMATA

	Number of cases	Clinical cures, under one year	Clinical cures, over one year	Still under treatment	Failures
Small and superficial	262	97	165	0	0
Extensive and superficial	28	7	15	4	2
Deep	32	9	6	9	8
Total	322	113	186	13	10

TABLE II

SQUAMOUS-CELLED EPITHELIOMATA

	Number of cases	Clinically clear, over six months	Still under treatment	Failures
Lesions of the ear	28	15	4	9
Lesions in other locations on the skin	11	5	1	5
Total	39	20	5	14

TABLE III

CUTANEOUS SARCOMATA

	Number of cases	Clinically clear, over six months	Failures
Melanosarcomata	4	0	4
Fibrosarcomata, small	2	2	0
Fibrosarcomata, large	4	0	4
Total	10	2	8

DISCUSSION*

DR. STEVENS. If any one thing is established, I think it is the radiation treatment of superficial malignancies. No doubt we get as good results, and I think better results, by this than by any other method, such as operation. Of course, it depends upon the type of growth as to how it should be treated. Basal-cell carcinoma of the skin will probably respond to almost any treatment. Operations probably give 80 to 90 per cent of cures, and radium will do the same. I think there is very little difference between radium and *x*-ray. In squamous-cell carcinoma the chances of success are much less, and in those I feel that we need the combination of radium and *x*-ray, because of the danger of metastasis. The neighboring glands, certainly in every case of squamous-cell carcinoma, should be rayed.

I noted in Dr. Quigley's paper, in speaking of cancer of the lip, he said nothing of radiation of the glands of the neck. I would like to know whether he carries this plan out, or whether he simply treats the local growth. It has been our custom, in these cases, to give the glands of the neck a deep *x*-ray radiation along with the radium radiation of the primary growth.

In melano-epithelioma the results are not so satisfactory, although Dr. Quigley reports several very good results. In reporting the case involving the eye alongside of the iris, he reminded me of a case I had some ten years ago. The case had been operated upon and a microscopic examination made, and the growth returned. It was reported melanosarcoma. The patient was referred to me by the surgeon who operated, I treated the growth with *x*-ray, and it cleared up. I have not heard from the patient for seven or eight years.

In cancer of the penis; I have treated 3 cases, in one of which there was involvement of the glands in the groin and suprapubic region. This was a very extensive case of squamous-cell carcinoma. I radiated the glands in the groin and suprapubic region with deep *x*-ray therapy, as deep as we knew how to give at that time (this was seven years ago) using 4 mm. of glass and a piece of sole leather, and cross-firing from several ports. Then I gave a very heavy dose of *x*-ray to the penis, immediately after which I sent the case to the surgeon. The penis was amputated and I gave postoperative radiation for two months. The patient is well today. The other cases had similar radiation treatment followed by operation and are well after two and four years.

When cancer of the face involves the periosteum, I have not been very successful with *x*-ray or radium alone, but have found that by combining electrocoagulation with radium I get very good results.

A sequestrum will have to be surgically dealt with later in these cases, but the final results are often very satisfactory.

DR. PANCOAST. One point in Dr. Quigley's paper which I wish to discuss is the treatment of

* This discussion has reference to the paper by Dr. Quigley, which appeared in February, as well as to the above.

epitheliomas involving the orbit. He said that as a rule they do not get well when the orbit is beginning to be involved. I think in such cases it is a question of sacrificing the eye or the patient. We find in these cases that when the eye itself is involved, and there is no chance to save it, the sooner it is removed the better, for then one has an opportunity to reach the point of extension into the orbit.

Dr. T. C. Kennedy. No case of cancer of the lip should be operated upon until radium has been thoroughly tried. If radium is used in cancer of the lip, by a thorough technician, there will be but few cases to go to the surgeon.

Pre-operative radiation has been advised, but if this is given, more than 60 per cent will be cured, and very few of the balance will be found fit subjects for operation.

In all cases, the glands should be thoroughly radiated. The cosmetic results from radium are far superior to those from surgery, which is an important consideration.

Dr. Lain. I do not wish to give a part of the paper which I am to present later to the section of dermatology of the A.M.A., but I wish to discuss this important phase of superficial epitheliomas of the lip. I fully appreciate what the authors have said about the apparent ease of curing superficial epitheliomas in certain places, but for fear some one inexperienced in this line of work may get the impression that they are all easy, I think we should stress the point that it is necessary to forestall metastasis by deep *x*-ray or a radium pack to the common metastatic regions. In my paper I have reported 97½ per cent cures in group No. 1. Two of the failures were due to our early inexperience, or lack of treatment of the submental and submaxillary glands. I do not think it is fair to classify all cases of epithelioma into a general group and declare a certain percentage of cures and a certain percentage of failures. The superficial type of epitheliomata of the lip, those not already involving the mucous membrane, will nearly all get well without raying the submental or submaxillary glands; but this is not true of any of those that involve the mucous membranes, are deeply infiltrated, or are adjacent to an abundant lymph drainage. You must forestall this class of cases by treating thoroughly the regions mentioned, and when you do, you will materially raise your percentage of cures.

Dr. Cole. I do not know the experience of others, but we find that the eyes are rather sensitive to both *x*-rays and radium. I do not claim any credit for originating this method of treatment, for I noted it in the *Annals of Ophthalmology*. In all cases involving the lids we have a little brass ovoid 1 cm. thick which we first immerse in paraffin, then we cocainize the eye, fill the eye cavity with petrolatum liquidum, and slip this ovoid in under the lids. We can then ray the lids without any irritation of the eyeball itself. I think this is a point well worth remembering.

Dr. Pfahler. In these cases of epithelioma that have invaded the ear or the nose, I think we can get them all well if we do electrocoagulation. In the case the doctor reported with involvement of the cartilage of the ear, I think if he would add electrocoagulation he would cure it. In the pigmented melanoma, I have never seen a case so treated that has recurred, or become malignant.

Dr. Quigley (closing discussion). First, in regard to glands in lip cases: When I started in with this work nine years ago we did not know as much about it as we do today, so we did not ray the glands. I have been raying glands for a couple of years, and believe it is the right thing to do. I think we will get a better percentage of cures when we do this thoroughly and routinely.

In regard to melanomata and the metastasis in these melanotic growths: The latter are exceedingly widespread, they occur by way of the lymph-vessels and blood-vessels both, and they occur early. So I believe it has come to be quite commonly accepted that no cases of melanomata are cured. It is a question of destroying them while they are still local. Some of them do grow quite large before any metastasis takes place. Some metastasize early and grow rapidly. The thing that causes the pigmented mole to grow a while before changing into a malignant growth is usually some irritation, something which is operating to produce metastasis, and in most cases we get metastasis. But if we can get the malignant mole before metastasis has taken place, we can cure the patient.

THE TECHNIQUE OF THE TREATMENT OF CARCINOMA OF THE CERVIX UTERI WITH A COMBINATION OF X-RAYS AND RADIUM RAYS*

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THE success of the radiological treatment of the deeply located cervical carcinomata depends on the solution of the problem: Is it possible to send into the interior of the true pelvis a dose of rays which is lethal to carcinoma tissue, yet will not cause permanent injuries to the healthy tissues and organs lying within the paths of the rays? The organs are the bladder, the rectum and the intestines.

The problem may be solved by determining:

1. The intensities of the *x*-rays and gamma rays of radium for the various distances. Thereby we are enabled to obtain the intensities of *x*-rays and gamma rays and, by a summation of these, the combined intensities at all points within the area of the body traversed by the rays.

2. A unit of dose which is based on a biological reaction. It is composed of the intensity and the time duration of the application of the rays.

3. A lethal carcinoma dose expressed in value of the biological unit of dose.

4. A technique of treatment based on the intensity of the rays, the biological unit of the radiation dose, and the lethal carcinoma dose.

1. *The Determination of Ray Intensities.* The intensities of *x*-rays are determined by the ionization method. We use the following factors for the production of the *x*-rays: A crest kilovoltage of 200 measured at the tube terminals with a sphere-gap of 12.5 cm. balls; a focus skin distance of 50 cm.; a filter of 1.0 mm. Cu. plus 1.0 mm. Al.; a field of 20 to 30 cm. square; a milliamperage of 5 and a large Coolidge treatment tube. The ionization chamber is placed on the surface of a water, paraffin or balsamwood phantom, so that one-half of the chamber is immersed in the phantom. The time is taken within which the ionization of the air in the chamber by the rays causes a discharge of the charged electrometer. The ionization chamber is next placed at a depth of 10 cm. from the surface. The time is again ascertained within which the electrometer is discharged.

The intensity at the surface is expressed in the time consumed to discharge the electroscope, i.e., I_0 is 14.2″; and the intensity at 10 cm. deep in the same way, i.e., I_{10} is 29.6″. If we place I_0 arbitrarily at 100 per cent then $I_{10} = \frac{14.2}{29.6} \cdot 100 =$ 48 per cent. The logarithmic graph of these *x*-rays which are practically homogeneous is a straight line. Hence, if we know the logarithmic values of two points of the straight, we know the values at any point. The logarithm of 100 is 2.0, and that of 48 is 1.68. The logarithmic values are entered on coordinates. The abscissae present centimeters and the ordinates the logarithmic values to the right and the per cent values of the intensities to the left. A line is drawn from 2.0 through 1.68. The natural numbers are read off at each centimeter. They represent the per cent of the intensity at each centimeter. We are now able to construct the absorption graph seen in II, Figure 1.

The intensities of gamma rays of radium are also obtained with the ionization method. We employ a chamber of the capacity of 0.5 c.c. and a gold-leaf electroscope. The conductors are constructed of brass tubing and a copper wire insulated with c.p. powdered sulphur and amber supports at the ends.

The quality of gamma rays depends on these factors: The amount of radium, the size and form of the capsules, the filters, the distance and whether the radium is applied to the surface of the skin, i.e., superficially, or within the tumor, i.e., intratumorally. In cervical carcinomata the insertions are intrauterine; hence we will only consider the intensities applied intratumorally. We placed two radium capsules each of 25 mg.

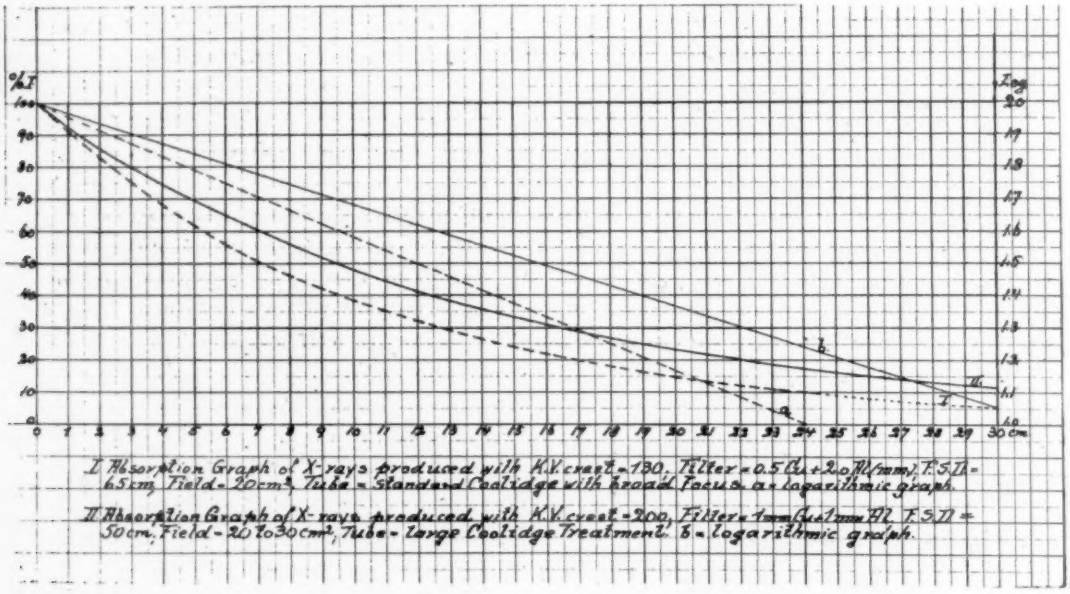
* Read at the Twenty-third Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Los Angeles, Calif., Sept. 12–16, 1922.

element in a brass filter of 1.5 mm. arranged as seen in Figure 3. The intensities are determined for each centimeter in the directions *a*, *b* and *c*, and corrected by the undesired radiation.

We then plotted the graphs of intensities seen in Figure 2. From these we constructed the isodoses or equal intensity curves seen in Figure 3 by simply placing the distances measured in the directions *a*, *b* and *c* at 100, 60, 40, 20, 10, 5 and 2.5 per cent on a plane.[1] We then had patterns made from each one of these equal intensity curves. If we draw a median longitudinal section

duration of the application. The quality of the gamma rays is also known by observing the factors given before and the quantity of the gamma rays by the time duration of the application, usually expressed in milligram element hours.

It is self-evident that various therapeutists will obtain the erythema skin dose (E.S.D.) within variable time durations of applications, even though the quality of the rays be the same. Red is red. One might consider a light red a complete reaction, another one a deep red followed by desquamation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I Absorption Graph of X-rays produced with K.V. creat = 130, Filter = 0.5 Cu + 2.0 Al (mm), F.S.D. = 65 cm, Field = 20 cm², Tube = Standard Coolidge with broad focus. a = logarithmic graph.
II Absorption Graph of X-rays produced with K.V. creat = 200, Filter = 1 mm Cu + 1 mm Al, F.S.D. = 50 cm, Field = 20 to 30 cm², Tube = large Coolidge Treatment. b = logarithmic graph.

FIG. 1. By means of these graphs the per cent values of *x*-ray intensities may be read off for each centimeter.

in natural size from measurements taken of the patient, and enter thereon the *x*-ray beams and their intensities and the equal intensity curves of radium, we know the intensities of either one and the combined intensities at any place within the pelvis[2] (Figs. 4 and 5).

2. *The Biologic Unit of Dose.* If *x*-rays or gamma rays are applied to the human skin and the skin surface exhibits an erythema after fourteen to twenty-eight days, we have given an erythema skin dose. Using the same quality and quantity of radiations, we can reproduce the erythema skin dose at will. The quality of *x*-rays is determined by the factors enumerated above, and the quantity by the time

of the superficial layers of the skin. Again, one transformer may give a full erythema skin dose within a shorter time than another. To eliminate such discrepancies it becomes necessary to employ standardized measuring instruments. With the iontoquantimeter we can determine the time duration of an application of rays to obtain a definite biological effect. Our instrument indicates an I_0 from the *x*-rays in 14.2″ using the factors enumerated before. If we change any one of the factors we obtain different values for I_0. If the value of I_0 is multiplied with the factor 6.32, we obtain a number indicating the number of minutes the patient must be exposed

to obtain a skin dose. Multiplying 14.2 with the factor 6.32 we obtain 90. We use 5 ma., hence the milliampere minutes amount to 450. This value gives the full 100 per cent erythema skin dose.

A celluloid box 6 cm. square and 6 cm. high was filled with water. The radium carrier was kept at a distance of 1 cm. between the bottom and the outside of the filter. This corresponds to the

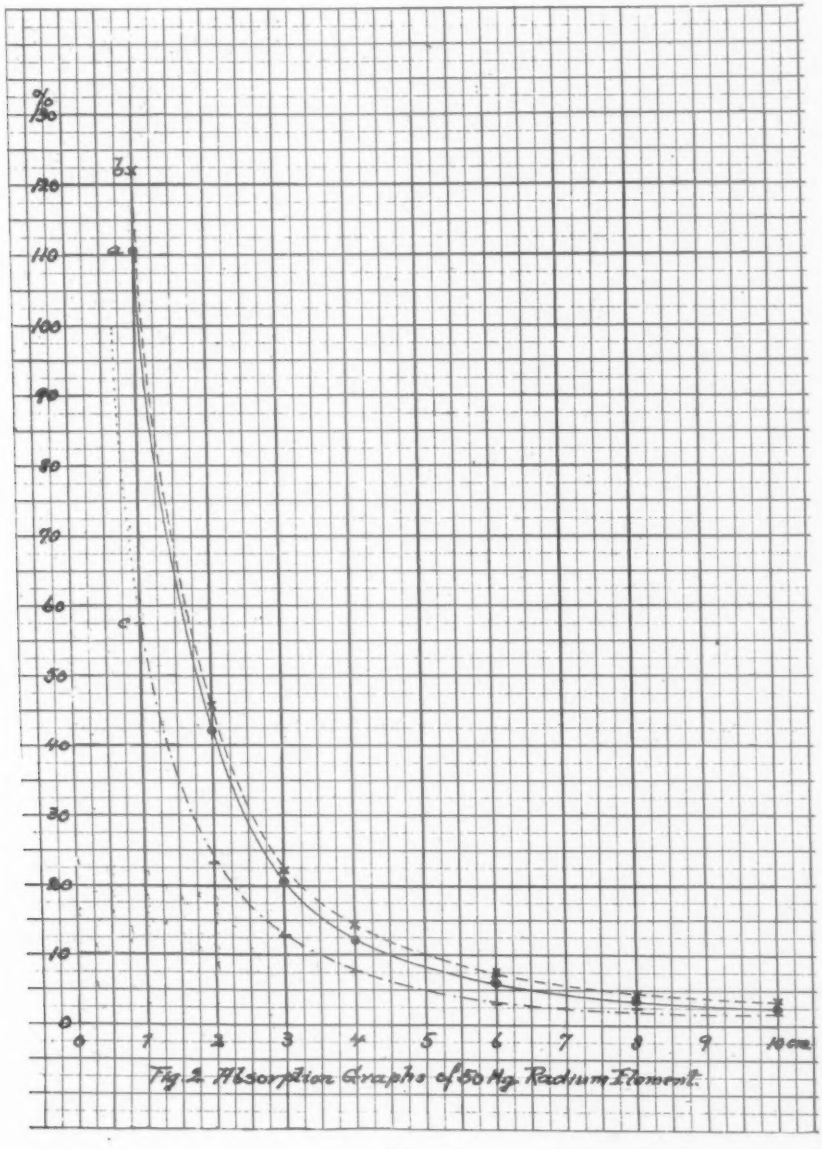

FIG. 2.

The E.S.D. of the gamma rays of the two radium capsules filtered with 1.5 mm. brass and placed as seen in Figure 3 has been determined as follows: isodose 60. The time duration of application to obtain a 100 per cent E.S.D. was twenty-four hours, or 1,200 mg. el. hrs. From these values the following 100 per

cent E.S.D. may be calculated for each one of the isodoses:

Isodose 100.0 100 per cent E.S.D. 14 hrs. 24 min.— 712 mg. el. hrs.
Isodose 60.0 100 per cent E.S.D. 24 hrs. — 1,200 mg. el. hrs.
Isodose 40.0 100 per cent E.S.D. 36 hrs. — 1,800 mg. el. hrs.
Isodose 20.0 100 per cent E.S.D. 72 hrs. — 3,600 mg. el. hrs.
Isodose 10.0 100 per cent E.S.D. 144 hrs. — 7,200 mg. el. hrs.
Isodose 5.0 100 per cent E.S.D. 288 hrs. —14,400 mg. el. hrs.
Isodose 2.5 100 per cent E.S.D. 576 hrs. —28,800 mg. el. hrs.

Knowing the E.S.D. in values of time duration of application or mg. el. hrs. for one of the isodoses, we can calculate the same factors for all the isodoses.

If we apply a 100 per cent E.S.D. to one of the isodoses, we can also calculate the intensities applied within the same time to all the other isodoses. Let us assume that we applied the radium for thirty-six hours, i.e., we have given a full E.S.D. to isodose 40. Hence

Isodose 40.0 = application 36 hrs. = 1,800 mg. el. hrs. = 100.00 per cent E.S.D.
Isodose 60.0 = application 36 hrs. = 1,800 mg. el. hrs. = 150.00 per cent E.S.D.
Isodose 100.0 = application 36 hrs. = 1,800 mg. el. hrs. = 250.00 per cent E.S.D.
Isodose 20.0 = application 36 hrs. = 1,800 mg. el. hrs. = 50.00 per cent E.S.D.
Isodose 10.0 = application 36 hrs. = 1,800 mg. el. hrs. = 25.00 per cent E.S.D.
Isodose 5.0 = application 36 hrs. = 1,800 mg. el. hrs. = 12.5 per cent E.S.D.
Isodose 2.5 = application 36 hrs. = 1,800 mg. el. hrs. = 6.25 per cent E.S.D.

Or we may intend to apply a 25 per cent E.S.D. at isodose 60. We obtain this intensity within six hours, i.e., 300 mg. el. hrs., as 100 per cent are obtained in twenty-four hours or 1,200 mg. el. hrs. The intensities obtained at the other isodoses with the 50 mg. ra. le. within the same time are:

At 60.0 25.0 per cent E.S.D. within 6 hrs. or 300 mg. el. hrs.
At 100.0 41.65 per cent E.S.D. within 6 hrs. or 300 mg. el. hrs.
At 40.0 16.66 per cent E.S.D. within 6 hrs. or 300 mg. el. hrs.
At 20.0 8.33 per cent E.S.D. within 6 hrs. or 300 mg. el. hrs.
At 10.0 4.16 per cent E.S.D. within 6 hrs. or 300 mg. el. hrs.
At 5.0 2.8 per cent E.S.D. within 6 hrs. or 300 mg. el. hrs.
At 2.5 1.4 per cent E.S.D. within 6 hrs. or 300 mg. el. hrs.

Friedrich has obtained different values for the E.S.D.[3] They are:

At 100.0— 1,000 mg. el. hrs., or 20 hours
At 60.0— 1,633 mg. el. hrs., or 35 hours
At 40.0— 2,500 mg. el. hrs., or 50 hours
At 20.0— 5,000 mg. el. hrs., or 100 hours
At 10.0—10,000 mg. el. hrs., or 200 hours
At 5.0—20,000 mg. el. hrs., or 400 hours
At 2.5—40,000 mg. el. hrs., or 800 hours

3. *The Carcinoma Dose.* An application of an E.S.D. of gamma rays or *x*-rays to a skin cancer will cause the tumor to disappear, in the majority of cases. The healing is completed within three to six weeks. The skin assumes a normal condition. We can safely give a 130 per cent E.S.D. The result will be a blistering of the surrounding skin. Six to eight weeks later the cancer has disappeared and the skin is regenerated. A whitish discoloration and telangiectases are the sole evidences of the more intensive radiation. However, if about a 200 per cent E.S.D. is applied, the cancer will become replaced by a radiation ulcer which may heal under proper treatment or resist all forms of treatment. If the ulcer persists it must be excised and covered with a pedicled flap of skin.[4]

Applying the E.S.D. to mouth carcinomata, as the tongue, the buccal mucosa,

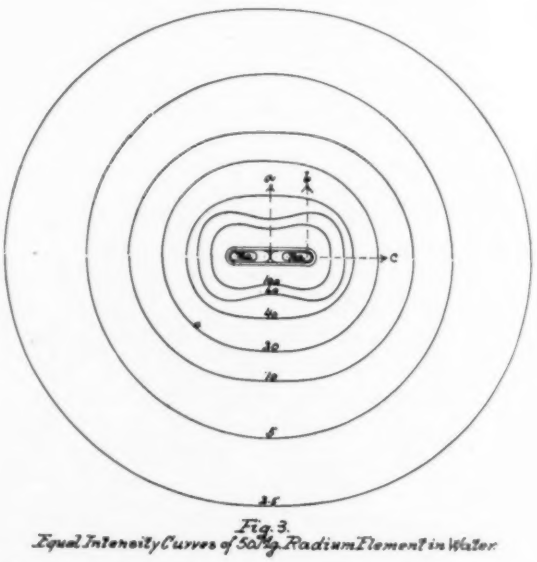

Fig. 3.
Equal Intensity Curves of 50 Mg. Radium Element in Water

FIG. 3. Patterns made of these equal intensity curves may be drawn in transverse or longitudinal sections of the pelvic organs. Thus we know the correct intensities of the gamma rays through the pelvis.

the pharynx, the following result will be observed: The carcinoma apparently

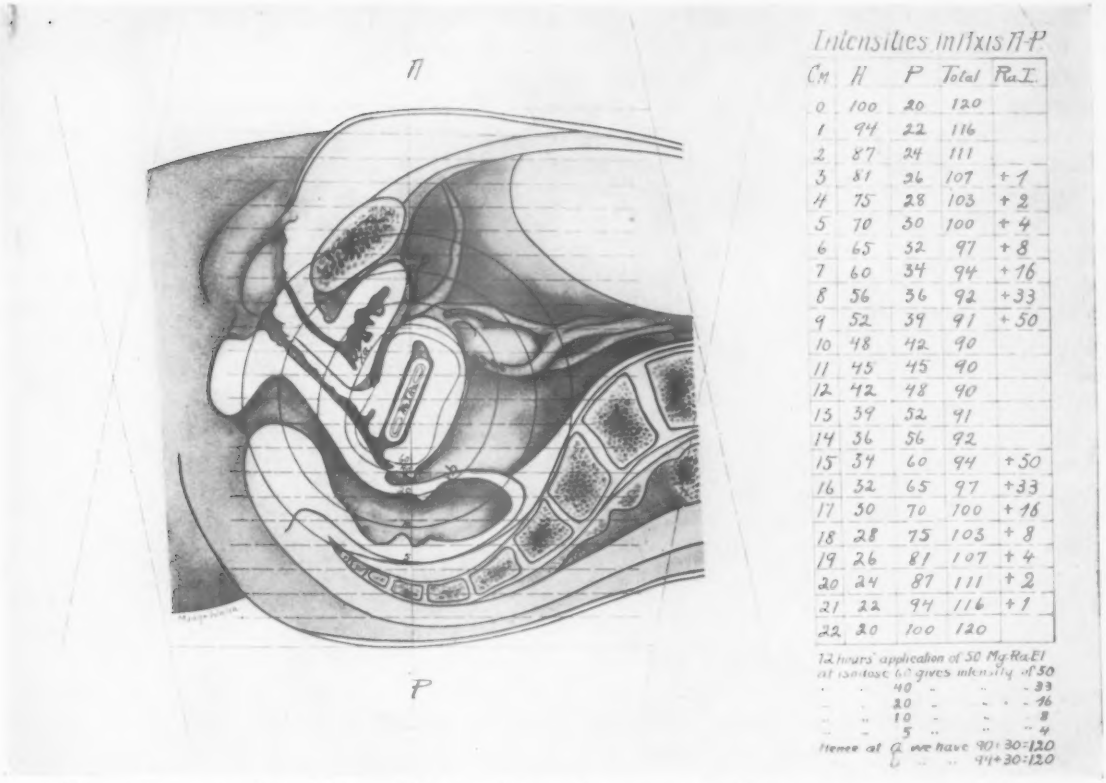

FIG. 4. The *x*-ray intensities and the equal intensity curves of radium on a transverse section.

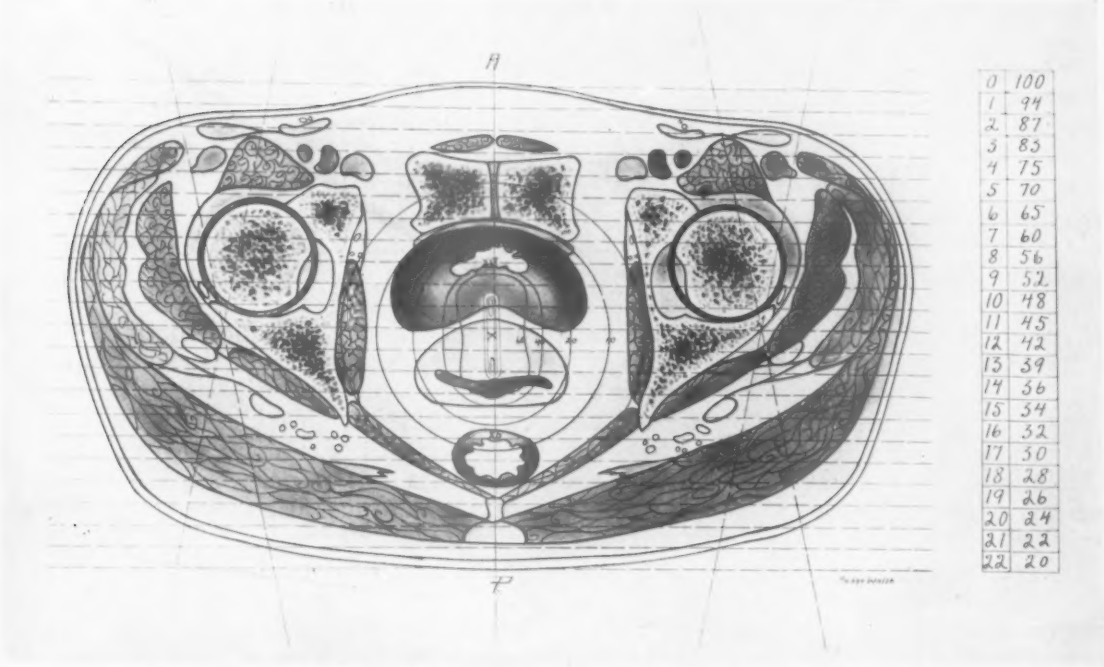

FIG. 5. The summation of the combined *x*-ray and radium dose on a median longitudinal section.

recedes completely; however, recurrences are frequent. This is probably due to the fact that these regions are subjected to the normal functions of the body. This causative irritation soon excites a recurrence. Hence it is advisable to remove such carcinomata with surgical coagulation following radiation treatment, if we wish to obtain permanent results. If the glands of the neck and jaws are subjected to such intensive radiations, the secretions of important glands are destroyed, due to the destruction of these organs. They are chiefly the pituitary, parotid, submaxillary, sublingual, thyroid and parathyroid glands. The patient, after an apparent recovery, begins to fail in health. Not a sign of the former carcinoma may be present. Yet the patient succumbs to a progressive emaciation. The balance of the endocrinal system has been disturbed, and the patient cannot live.[5]

We may apply a full dose to a chest cancer. The patient may exhibit signs of a radiation toxemia; the blood changes also may be pronounced. Yet the intensity of these reactions is seldom dangerous to life. If we give radiation treatment to the abdominal cavity, important glandular structures are traumatized, such as the adrenals and the pancreas. We should always attempt to protect one of the adrenals by superimposing a sheet of lead over one of the renal areas, especially if we treat a pyloric carcinoma. This is accomplished by tilting the patient towards the left. We then can avoid the right adrenal gland. Toxemia, vomiting and diarrhea, also, are pronounced. They result from the direct action of the rays on the gastrointestinal tract and the indirect action of the rays producing toxic substances liberated by the action of the rays on the cells. The latter are a gastrointestinal poison. Weeks pass by before the patient regains a tolerable state of health. During this period he cannot activate the defensive forces necessary to increase the avidity of the normal cells, thus enabling the latter to absorb the degenerating carcinomatous neoplasm. The stomach and intestines are also subjected to the same causative irritations, i.e., the normal physiological functions, unless we can exclude the diseased part from the gastrointestinal tract by surgical intervention, as gastrojejunostomy, enteroenterostomy, colostomy, etc. The conditions in the urinary tract are identical with those in the gastrointestinal tract. The changes in the blood also might be very severe, but could be overcome by transfusions of whole blood.

These detrimental factors are not found in uterine carcinomata. Important ductless glands are not located within the radiation fields, except the ovaries. The uterus is destroyed, ovulation and sexual activity, i.e., the physiological functions cease. The fields of radiation must be just large enough to cover the small pelvis, thus to reduce the injuries to the blood stream and intestinal mucosa. Still we observe toxemia and leukopenia, at times of an alarming degree. On the whole, however, the patient recovers and progresses to perfect health.[6]

These facts are stated to impress you with the importance of practicing an exact dosation. When applying the roentgen rays, the field must be just large enough to cover the diseased area. The rays are dangerous, and we must not employ them promiscuously. We should not apply more than 450 to 600 ma. min. of a 200 kv. radiation, or radium above an erythema skin dose beyond the isodose 40, and much smaller amounts, if *x*-rays and gamma rays are being used in combination. The carcinoma should be destroyed with the smallest lethal dose that will do the work. By the combined use of *x*-rays and gamma rays we are able to reduce the time of application of either agent. The systemic intoxication, the injuries to healthy tissues and organs and the destruction of blood corpuscles are kept at a minimum. A simple calculation will demonstrate that we would have to increase the milliampere minutes of *x*-rays up to 100 per cent to obtain a 130 per cent E.S.D. at the cervix. We must use from 750 to 900 ma. minutes over each field, i.e., the anterior and the posterior field. The technique of the combined radiations, therefore, reduces the time of *x*-ray exposure at least 50 per cent.

The greatest danger from radium is its local destructive effect. This absolutely

prohibits exposures that could destroy carcinoma tissue beyond a radius of 2.5 cm. Again the time duration of the application of radium can be kept within safe limits by the technique of the combined radiation.

It therefore, is our custom to apply the *x*-ray so to obtain a 120 to 130 per cent

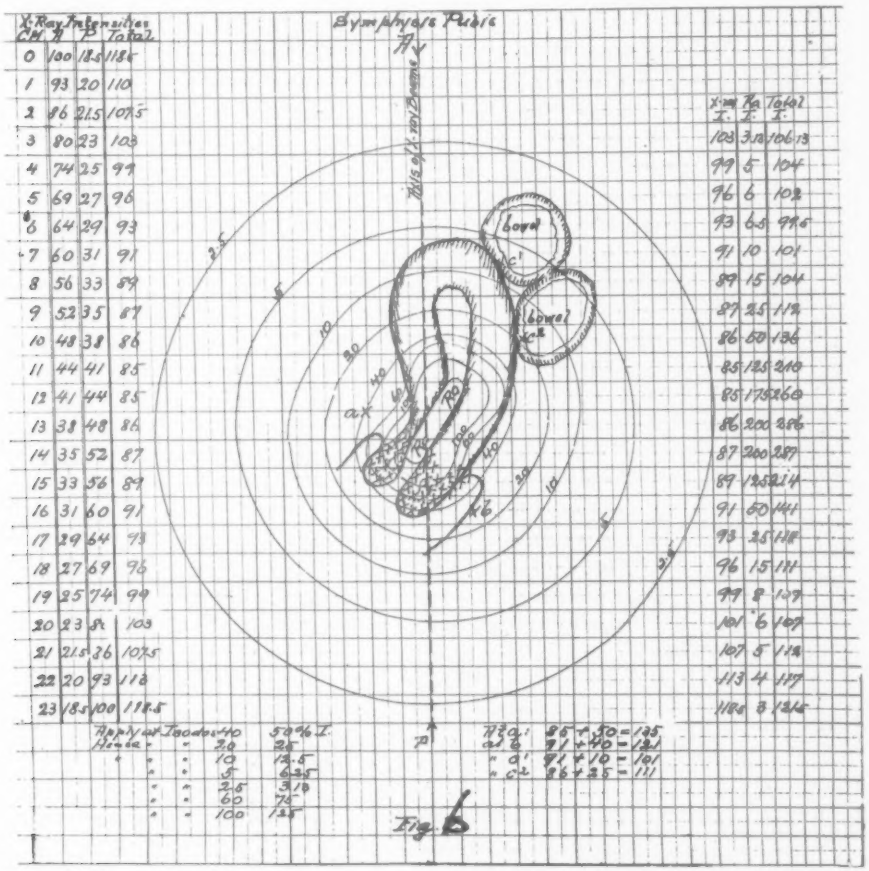

FIG. 6. The application of the problem in actual practice. The uterus is in anteversion.

E.S.D. on the skin over each one of the two ports of entry and supply the deficiency within the region of the uterus by such a gamma ray dose that a homeogeneity of 110 to 130 per cent E.S.D. is obtained within the area radiated, though the uterus might receive a much higher dose with impunity.

In the preceding paragraphs I have not referred to the variations in radiosensibility of carcinomata which are dependent on the epithelial-cell type and the abundance of the connection tissue frame-work of the tumor. We must concede that the basal-celled epithelial cancer reacts more rapidly to radiations than the hornifying epithelioma, the cylindrical epithelial cell growth or the adenocarcinoma. The medullary carcinoma responds much sooner to radiations than the scirrhus type. The former is composed almost totally of embryonal cells, and the latter exhibits a varying proportion of adult differentiated tissue.

However, a lethal carcinoma radiation dose exists which will cause degeneration and recession of the cancer in the greater majority of cases subjected to this treatment.

4. *The Technique.* The uterus is contained within the true bony pelvis. The widest extent of the carcinoma may be assumed to be confined to this space. If the inferior and superior lumbar lymph-nodes are involved, the cancer disease has

become generalized. Such a case is hopeless. The axis of the uterus corresponds, in most instances, to the axis of the true bony pelvis. The cervix lies in a straight line drawn vertically through the superior ramus of the symphysis pubis and posteriorly through the sacrococcygeal synchondrosis. The axes of the *x*-ray beams should lie within this line. We determine the measure the anteroposterior diameter and the depth of the cervix. The length and inclination of the uterus are determined by a flexible uterine probe. The results of these measurements are plotted on centimeter paper (see Fig. 6). We enter in column 1, the centimeters; in column 2, the *x*-ray intensities given through the anterior field for each centi-

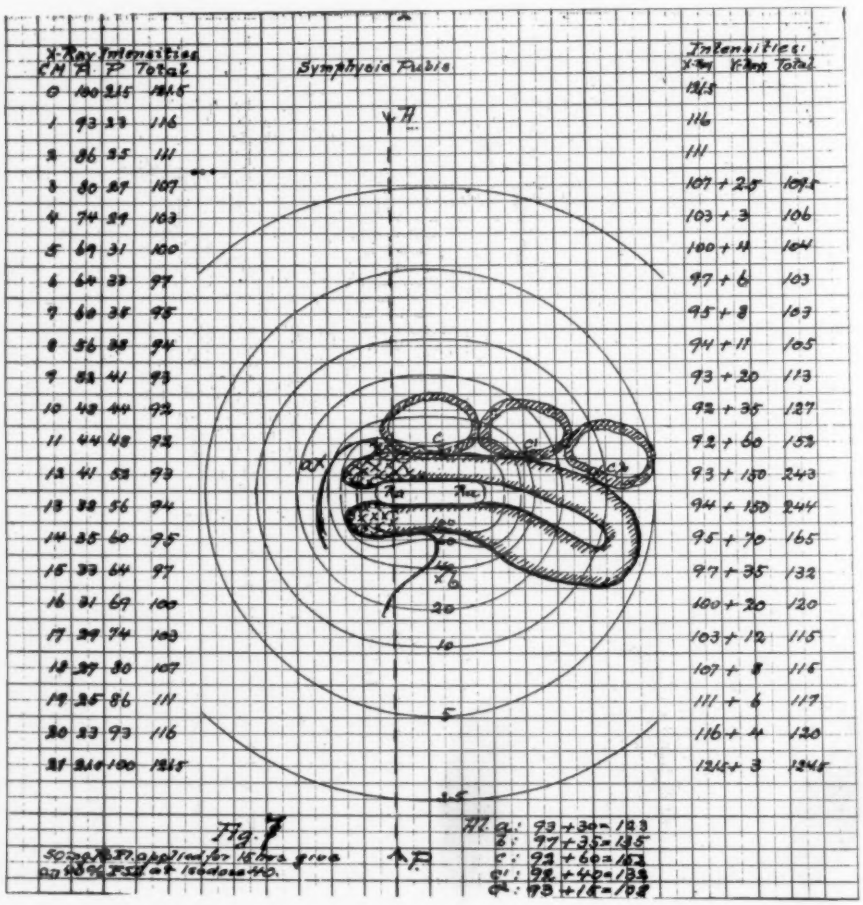

FIG. 7. Another example. However, the uterus is in retroversion.

anteroposterior diameter of the pelvis of the patient. It varies from 15 to 26 cm. Values lower or higher than these are the exception. About 60 per cent of women have anteroposterior diameters of 18 to 21 cm. We also locate the position of the cervix by measuring its distances from the anterior abdominal wall and the perineum. The former distance is mostly two-thirds of the total anteroposterior diameter. We use a modified pelvimeter meter by means of graph II in Figure 1; in column 3, the *x*-ray intensities given through the posterior field; and in column 4, the sum of *x*-ray intensities obtained at each centimeter with both beams.

We then draw the radium capsule in an exact position in the uterine canal and by means of the patterns of the equal intensity curves we enter the isodoses. The posterior bladder wall and anterior rectal wall are then indicated by the stars at

a and *b*. The loops of intestines are marked *c*, c^1, and c^2; *a* and *b* are usually 2.5 cm. distant from the cervical canal, if the bladder and rectum are empty. If the bladder and rectum are distended, they are forced closer to the cervical canal. This must be avoided. Hence the bladder is kept empty by the use of a retention catheter and the rectum by castor-oil and enemas and a liquid diet.

The posterior bladder wall and the anterior rectal wall are the locations mostly and irreparably traumatized by injudicious radiations. The maximum dose that the vesical and rectal mucosae will bear without permanent injuries is 130 per cent of an E.S.D. We therefore must attain a dose of 130 per cent or less at points *a* and *b*. The dose should not exceed this limit, under any conditions. Overdosation causes stricture of the rectum and contraction of the bladder, resulting in vesical and rectal tenesmus, and frequently, in rectal stricture and bladder contraction. If the dose has been too large, necrosis occurs with the formation of vesico- and recto-vaginal fistulae. Such results cloud the success of radiation therapy. The patient, though relieved of the cancer disease, has exchanged her primary invalidism for another one of at least the same intolerability.

The *x*-ray dose at *a* is 76 per cent of an E.S.D. and at *b*, 82.5 per cent. The additional intensity of radium to bring the dose to 130 is, therefore, 50 per cent. Points *a* and *b* lie about midway between isodoses 40 and 20 at about the isodose 30. If we apply a 100 per cent E.S.D. dose with gamma rays at isodose 60, we obtain a 50 per cent E.S.D. at isodose 30. It means that we must insert the radium for twenty-four hours. The doses obtained at the other isodoses are as follows:

At isodose 60 a dose of 100 per cent by applying 1,200 mg. el. hrs.
At isodose 100.0 a dose of 166.5 per cent
At isodose 40.0 a dose of 66.6 per cent
At isodose 30.0 a dose of 50.0 per cent
At isodose 20.0 a dose of 33.3 per cent
At isodose 10.0 a dose of 16.7 per cent
At isodose 5.0 a dose of 8.3 per cent
At isodose 2.5 a dose of 4.2 per cent

The combined doses at each centimeter are entered in the columns to the right in Figure 6, demonstrating that with a combined use of radium and *x*-rays a radiation dose can be administered destructive to the uterus and the carcinoma without injury to the neighboring healthy organs and tissues. The doses beyond *a* and *b* anteriorly as well as laterally, are always smaller than the doses at these points.

Let us consider another case of cervical carcinoma in which the uterus lies in retroflexion. The bladder is now forced closely on the vaginal portion of the cervix; the fundus compresses the rectum posteriorly; the intestines lie upon the anterior surface of the uterus. We force the bladder and rectum away from the cervix by distending the anterior and posterior vaginal fornices with gauze pads. The small bowels are so close to the radium capsule (about 2 cm., i.e., the thickness of the anterior uterine wall) that they probably will receive too large a dose. However, even if a perforation should result, the peritoneal adhesions will protect the patient. The liquid chyle has no difficulty to pass the bowel, should it become constricted. The solution of such a problem is seen in Figure 7.

SUMMARY

1. The methods for the determination of the intensities of *x*-rays and gamma rays have been described.

2. A definition of the biological unit of the radiation dose has been given. It is designated as a 100 per cent E.S.D. This dose is measured with an iontoquantimeter, that is, standardized. The same dose, therefore, may be reproduced for all qualities of rays.

3. The lethal carcinoma dose has been determined. It is, on an average, from 110 to 130 per cent of an E.S.D.

4. A technique has been developed, based on these investigations, which enables anyone to solve the problem of the successful treatment of cervical carcinomata with the combined use of *x*-rays and gamma rays of radium.

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DISCUSSION

Dr. Ernst. I think it has been a privilege to listen to the paper of Dr. Schmitz and also to read over many of the papers, especially the one by Dr. Opitz of Berlin.

In looking over the conclusions it does seem, with some exceptions, that perhaps the best we can say for the present time is that the more intensive present methods of radiation with the more homogeneous rays do give us better results, but having reached this conclusion it seems that our troubles have just begun.

Dr. Schmitz' work is certainly commendable from the viewpoint that it tries to give more exactly the dose we ought to give to protect those structures which perhaps need protection. I firmly believe that it is a question of keeping our dose within the range of the minimum and maximum.

I have a few little extracts here from Dr. O— which I think are worth while considering. He makes the following definite statements: He speaks of the retrogression of cancer as not being due solely to immediate action of the rays. He further states as to the question of cancer dose that there is, according to S & R, at the present time no curative or definite dose such as 90 or 100 per cent erythema. However, he states that in the majority of cases of mammary and uterine cancer retrogression may be expected from administration of such a dose. He likewise presents another interesting observation with reference to the principle of radiotherapy in cancer of the breast and uterine conditions, and refers to a large series of treatment cases showing cure of five or more years and manifested only by slight erythema on the skin. He examined all of those cases and noted the results, and then examined cases in which there was marked erythema, and the condition of these cases was considerably more pronounced. He is very emphatic in the statement that an overdose should be considered dangerous as it weakens the local cells which are the defensive forces of the body.

Now as to the question of the amount of radiation at one time; O—— prefers giving frequent radiation from six to eight weeks with doses slightly less than the maximum cancer dose. With this method of divided doses many of us do not altogether agree, although I feel there must be some merit in such a technique.

In about 25 per cent of the cases we have been treating in the past ten months, by force of necessity we had adopted such a course and I was surprised at the rather marked improvement over the single doses which we would like to give and think ideal; but that question of the amount of radiation and the question of staying within the limits of the maximum and minimum radiation is certainly something we must consider carefully.

The value of both the radium and the *x*-ray together with the anatomical situation of pelvic conditions is certainly of importance to all of us. However, any method or methods adopted certainly should be adjusted to the conditions of the individual case, and we should make every effort to keep within the boundary of the minimum and maximum dose.

Dr. Martin. I would like to ask about this 135 per cent dose that Dr. Schmitz spoke of as being safe for the intestine. I would like him to tell us definitely how he knows positively that 135 per cent is safe for the human intestine. I do not feel it sufficient to measure dosage with the iontoquantimeter and make a definite decision on the biological reaction therefrom.

Dr. Chamberlain. If Dr. Schmitz thinks it worth while he might say something about idiosyncrasies. We heard a great deal about this and as measuring devices and methods became more accurate we heard less and less about idiosyncrasies. Lately we have been hearing more about it again and it seems to some of us that as the measuring methods again catch up with the apparatus that we will hear less of idiosyncrasies,—at least as regards very marked or important degrees of variation in susceptibility.

Dr. Schmitz (closing). We have treated about 300 cases with the new therapy and about 50 with the old. From clinical experience we know what happens. In examining our patients we invariably make a bladder and proctoscopic examination; so we know exactly the condition of the organs before and after radiation. With our present methods we have never seen permanent secondary effects in the small intestine. However, I do not think that would hold good. I can only say that with this new method we have had only one result. Patient died three days after radiation directly from the effects of the radiation. I used very poor judgment in giving one full dose anteriorly, causing a degeneration of a large amount of

tissue which killed the patient, but it was not due to intestinal disturbance.

The question arose. How did I determine the 135 per cent erythema skin dose? If you multiply the seconds which are necessary for dosage of certain ?? of *x*-ray by 35 per cent you get the erythema skin dose. F—— says 90 per cent skin dose will kill cancer. The ratio between the G——— and F——— dose is five to ten. My skin dose is actually three times larger than G—— and twice as large as F——. G——, with this technique, gives three series of treatments six weeks apart. At each time he radiates the same fields. We only give one series of treatments and never repeat a treatment, and we are sure this does no permanent injury to the skin.

In regard to idiosyncrasies,—if you treat a case of smallpox you know it takes a definite amount of units of antitoxin to do the job and that is the average dose for a patient, and yet you will find cases where you will have to increase the dose and others where you must make it smaller. It is the same with *x*-rays. By experimental work you determine your patient's needs. Some patients might receive too much, but finally the patient has cancer and there is very little lost.

A NEW RADIUM CHART

BY LAWRENCE A. POMEROY, M.D., F.A.C.S.

CLEVELAND, OHIO

RECENT changes in the provisions of many policies covering the loss of radium make it desirable to know definitely what house officer or what nurse is responsible for the radium during the different portions of the entire time consumed by one treatment. To aid in obtaining and recording this data the following chart has been devised.

In the first column the time is recorded in hours and minutes. In the second column the operator writes the name of each nurse opposite the time she is to be in charge of the patient. In the third column the nurse is to sign her name when she receives the radium or assumes charge of the patient. This plan provides a written receipt for the radium from the time it is applied to the patient until it is removed and placed in the hospital safe.

If the patient is in a ward, and not in charge of a special nurse, the use of this chart shows definitely what nurse is responsible for the patient and the radium at any given time.

RADIUM CHART

Mrs. Smith at City Hospital.

Treatment given from June 15 to June 16

Hour:	Radium applied by Dr. Jones	Signature of Individual Responsible for Radium
9 45 A.M.	Patient in bed in charge of:	
9 55 A.M.	Miss Brown.	A. Brown
9 55 A.M. to 7 P.M.	Patient in charge of: Miss Brown.	A. Brown
7 00 P.M. to 7 00 A.M.	Patient in charge of: Miss Green.	B. Green.
7 00 A.M. to 7 45 A.M.	Patient in charge of: Miss Brown.	A. Brown.
	Patient in charge of:	
	Patient in charge of:	
7 45 A.M.	Radium removed by: Dr. Black.	C. Black.
7 45 A.M.	Radium placed in office safe by: Miss White	D. White

Each person responsible for the radium must sign in the last column when receiving the radium or when taking charge of the patient. This slip should accompany the radium when it is sent to the safe in the office.

THE TREATMENT BY RADIATION OF CANCER OF THE RECTUM*

BY HARRY H. BOWING, M.D., AND FRANK W. ANDERSON, M.D.

Section on Radium and Roentgen-Ray Therapy, Mayo Clinic

ROCHESTER, MINNESOTA

I WAS asked by the Program Committee of this Association to present a paper on the end-results of treatment by radiation of cancer of the rectum. After considering the matter, I decided that statistical data of value could not be obtained in so short a time. Moreover, the topic was being investigated in the Clinic from the surgical standpoint. I decided, therefore, to confine my discussion chiefly to a description of the technique as it is used in the Mayo Clinic.

Da Costa, before a recent meeting of the American College of Surgeons, said that in his experience, radium relieved pain, and that in certain cases in which the growth seemed hopeless, it did give hope. He expressed the belief that radium, used with the knife, with sound clinical judgment, could be recommended as a valuable adjunct, but that a physician who uses radium for all cases is as much a menace to the public as the physician who uses strychnin or the roentgen rays for all diseases.

Recently, W. J. Mayo mentioned that he is favorably impressed with the results of a combination of surgery and radiation in the therapeutic management of rectal carcinoma. He recalled several inoperable cases which became operable following radium exposures, and deplored the fact that many physicians are giving radium treatments with little or no experience, and in many instances with insufficient radium.

Hayward Pinch expresses the opinion held by all competent radiologists as follows:

"It is to be regretted that within the past twelve months statements have been published in the lay press to the effect that radium is a failure, and these appear to have originated in the pronouncements of some well-meaning but ill-informed practitioners concerning a subject of which they possess but very little personal experience. As these statements are not infrequently alluded to by patients and their friends, it is obvious that considerable harm has been done by their dissemination, and it therefore appears desirable strongly to controvert the assertion. Radium is not a failure when used intelligently and scientifically, and applied to the treatment of those conditions which experience has shown are amenable to its action. No honest worker claims, or has ever attempted to claim, that radium is to be regarded as a panacea, or as a cure for malignant disease, and many years must elapse and much more research and clinical work be done, before it will be justifiable to use the word 'cure' even in selected cases of malignant trouble. It is best, therefore, to speak only of 'arrest of the disease,' and this can be truthfully affirmed in very many instances. Patients whose lives would have speedily terminated, and who would have suffered much intense agony, have been enabled by radium treatment to live for many years in comparative comfort after all the known resources of medicine and surgery had been exhausted. That in radium we possess an addition to our armamentarium of great value, is a fact which cannot be challenged, and it is distressing to think that a rash and ill-advised statement, by its wide publicity, should have deprived many patients of fresh hope and possible benefit."

Levine has said, "Surgery, while meeting with some degree of success, has not solved the cancer problem. A comparative analysis of vital statistics and cancer statistics shows that in the hands of different surgeons, the highest percentage of all cancer cases of a community which can be cured by surgical treatment is 15.25 per cent, and the lowest 4.15 per cent, or, in all probability, less than 10 per cent."

*Read at the Seventh Annual Meeting of THE AMERICAN RADIUM SOCIETY, St. Louis, Mo., May 22–23, 1922.

Radium, when properly applied, will bring about a definite inhibitory and destructive effect in the majority of rectal neoplasms. There is an abundance of evidence available to prove it to be a valuable adjunct when added to our present surgical procedures to combat rectal cancer, and that, in selected cases, it should be used as a pre-operative and postoperative measure.

The impossible is usually expected of radiation therapy. The majority of patients are beyond the aid of surgery or any recognized method of treatment. Many cannot be treated intensively. The majority of patients, three and five years ago, received inadequate and poorly applied treatment, when compared to our present methods. These factors make statistical study practically valueless.

The day is not far distant when cases will be classified as favorable or unfavorable for radiation therapy. The lesion may be grouped as one responding to radiation, but its location, extent and special characteristics will not permit of thorough treatment. The chief element of defeat is the lack of sufficient exposure of the tumor.

More than 300 cases in the Mayo Clinic have been treated. The majority were inoperable and only a reasonable amount of placebo treatment was given. Many of the treatments were postoperative and prophylactic. Some of the cases were recurring following radical surgical procedures. Twenty or more patients received pre-operative radium exposures. One or more, whose cases were operable, decided in favor of radium. In about 6 inoperable cases a radical posterior resection was performed after radiation therapy. No added surgical difficulties are recorded. A few patients stand out as receiving sufficient treatment to arrest the process.

McVay, in a study of 100 patients operated on in the Mayo Clinic for cancer of the rectum, made observations as follows:

"The anorectal lymph-glands are four to eight in number and are situated on the posterior and lateral walls of the rectum. The size of the growth in the rectum cannot be relied on as an accurate index to the probable lymphatic involvement. Without lymphatic involvement there is a tendency of the growth to expand into the lumen of the bowel. The growths with some lymphatic involvement tend to spread by direct extension, and are slow growing. Carcinomas of the rectum, with extensive glandular involvement, tend to metastasize through the lymph stream early. Occasionally metastasis may take place by emboli breaking off into the portal vein. Rectal carcinoma is the most common form of intestinal growth, and represents 5 per cent of all cancers of the body. It is more common in men than in women.

"Metastatic involvement of the glands can only be definitely determined by systematic microscopic study of all the regional lymph-nodes. The size of the node is not an efficient means of determining whether or not there is metastatic involvement. This is particularly true if the amount of involvement is small or if the process is early."

Most cancers of the rectum are adenocarcinomas; the growth may be: (1) Bulky with partial or complete involvement of the walls of the rectum; (2) tabular with partial or complete involvement of the walls; (3) smooth, annular, and contracting with nearly complete obstruction; (4) multiple, occurring as polyposis. Each group presents difficulties for the radiologist. Each patient must receive individual treatment with applicators adapted to fit the requirements of intensive therapy. The cases can readily be classified into three groups:

I. *Operable Cases.* A digital, and in some instances, a proctoscopic examination, made the diagnosis. Exploration of the abdomen showed an operable growth in the rectum with no gross distant metastasis. A left rectus colostomy was made, and, a few days later, radical posterior resection was performed. As soon as surgical convalescence permitted, the deep end of the distal colostomy loop and the posterior resected area were treated with filtered radiation. Twenty-two patients received radium before resection; that is, two to three applications at intervals of two or three days. At the end of two weeks following the first application, the resection was

performed. One patient refused operation. Bare glass tubes were buried in the growth. A few other patients, on account of some contraindication to a general anesthetic or too great operative risk, received only radium treatments.

II. *Inoperable Cases.* The diagnosis was determined by either digital or proctoscopic examination, and in borderline cases, an exploration was made. A few operable cases, on exploration, revealed distant metastasis, or a second growth high in the rectosigmoidal area. The most outstanding subdivisions of this group are the few cases in which sufficient reduction of the tumor was obtained by radiation to warrant posterior resection. In some, a thorough microscopic search of the structures removed did not disclose cancerous tissue. I found 3 similar cases reported in the literature.

The first reported case of excision for cancer of the rectum following radium treatment was observed by Symonds in 1914. The patient, a man, aged seventy-three years, had an annular growth 4 cm. from the anus; on section it was found to be carcinoma. On five consecutive days, for six hours each, 100 mgm. of radium was applied, screened with 2 mm. lead and 3 mm. rubber. Eleven days later, visual and palpable examination revealed that the growth had disappeared and only a ring of cicatricial tissue was present. Six months and twenty-six days after the application of radium, a perineal resection was performed. The proximal end of the rectum was sutured to the anal portion and the sphincter was saved. Complete union followed. One month later, the colostomy was closed. Microscopic sections did not reveal the presence of active carcinoma.

The second case observed was reported by Handley. The patient, a man, aged sixty years, had a small bleeding area 12.5 cm. from the anus. Specimens removed for examination proved to be carcinomatous. The condition was considered inoperable. On September 6th, with the aid of a sigmoidoscope, 150 mgm. radium bromid, filtered through 2 mm. platinum was applied to the stricture above the ulcer area for nine hours. It was then applied to a higher area for twelve hours, and to a lower area for ten hours.

Two weeks later, a severe local reaction occurred, but one month after treatment, the bleeding and pain had ceased. At this time, edges of the ulcer were flat, and the stricture appeared to be simple. Two months after the radium treatment, colostomy was performed, and the growth removed. At operation, 160 mgm. radium bromid filtered with 1 mm. silver, 2 mm. platinum, and 2 cm. gauze was applied in the abdominal wound for twenty hours, and 50 mgm. radium bromid filtered with 1 to 2 mm. silver, 1 mm. lead, and 4 mm. gauze in the perineal wound.

A large abscess in the right side of the pelvis had to be opened on the tenth day, and there was some suppuration in the abdominal and pelvic wounds. Sixteen days after operation, 150 mgm. radium filtered as previously was applied high in the pelvic sinus for twenty hours. One year later, the patient was in good health.

The third case reported was observed by Durand. The patient, a man, aged fifty-four years, had a circular neoplasm 2 cm. from the anus. The canal barely admitted the finger, and extirpation appeared difficult. One hundred and ten milligrams of radium was applied for forty-four hours. Five weeks later, a "Lisfranc operation" was performed. No added surgical difficulties are recorded. The lesion was found to be greatly modified and almost cicatrized.

III. *Recurring Cases.* The patients in this group had had radical resections, and some of them had had radium treatments postoperatively. They returned for further observation and treatment at varying intervals following operation. A few received marked palliative relief, and some were seemingly in good health. The relief from obstruction, the absence of bleeding, the lessening of pain, etc., account for the initial improvement. It is not easy to establish a diagnosis of recurrence. The character of the discharge may help; if possible, a small specimen should be removed for microscopic examination. In 1 or 2 patients in this group in whom recurrence was suspected, a hypodermic needle was introduced into the mass with

the escape of pus. With sufficient drainage, the condition cleared up.

TREATMENT

Cancers of the rectum are difficult to treat, since the tumor is incased in the bony pelvis with only a small contracted sinus in which to place the radium. If the inguinal glands are enlarged, they should be treated as metastatic processes. The radium is applied to the skin surface overlying the enlargement.

The treatment should be individual. I am confident that certain groups of patients cannot be treated according to a therapeutic framework. Every avenue of approach should be used in order thoroughly to radiate the tumor. The vaginal mucous membrane tolerates radium rays very well. If the rectal mass can be palpated by vaginal examination, the cavity should be packed with radium. The treatment should be either prophylactic or intensive, as the case demands.

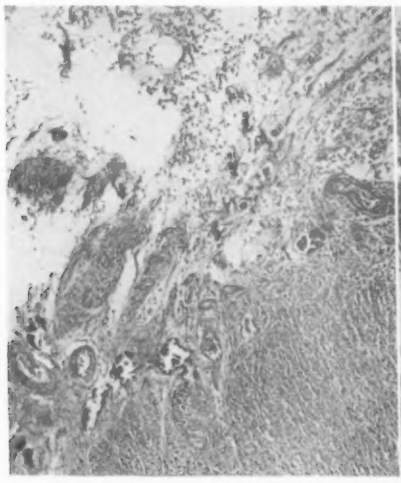

FIG. 1. Remains of carcinoma and musculature of rectum and apparent direct extension from primary carcinoma tissue completely devitalized.

FIG. 2. High power of Figure 1.

Technique. The technique of radium application should be simple and yet consistent with good treatment. The applicator must remain as placed for the allotted time; this is assured by making the patient as comfortable as possible. The applicator should be designed so that it can be fixed to the body surface, to insure constant exposure of the tumor, and avoid accidental injury to adjacent normal tissue. The tumor tissue, if properly radiated, loses all morphology and is replaced by fibrous connective tissue. Overradiation should be avoided, especially in cases in which radical removal is under consideration in order to avoid added surgical difficulties. In selected cases, pre-operative radiation and a sufficient time interval before the radical removal will improve the case for surgery and give greater assurance against local recurrences. It will reduce to a minimum the chance of dissemination, since the primary growth has been almost completely devitalized, and has lost all power of rejuvenation. This has been proved by microscopic examination of specimens removed from the original tumor area (Figs. 1, 2 and 3). A minimal amount of exposure of doctor and nurse in preparing and placing the applicator should be an important factor in the construction of the applicators, and they have been adapted with these factors in view.

No distinction is made between the applicator containing a salt of radium, and a tube of radium emanation prepared by the Duane series of mercury pumps. Radium C, with its alpha, beta and gamma rays is the therapeutic principal, regardless of its source. The Universal tube applicator

with walls of silver 0.5 mm. thick, containing 50 mgm. radium sulphate by measurement, may be used, or a modified tube applicator (Fig. 4, No. 2) with walls of brass equal in filtration to the

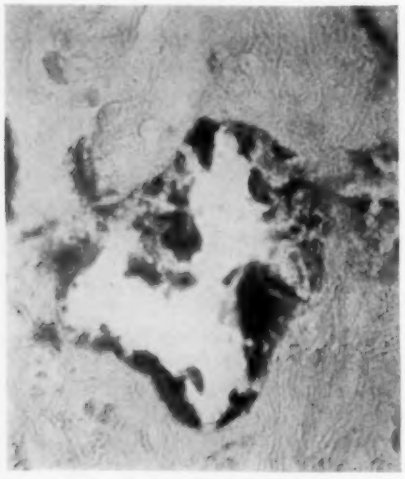

FIG. 3. Remnants of devitalized nuclei, impossible of regeneration.

silver tube, into which are placed small glass tubes containing emanation. The tubes usually measure 50 to 75 mc. The applicator shown in Figure 5, No. 2, is suited for the treatment of small and narrow sinuses, and can be introduced into drainage tubes at operation. The stem will bend to suit the contour of the body, and can be fixed with adhesive plaster.

To the stem (Fig. 5, No. 3) which has been devised to accommodate the Universal silver tube applicator, a brass shell is fixed with very thin walls, for it is not intended to act as a filter. A Para rubber tube, with walls 1.5 mm. thick, fits over the shell and extends 5 to 8 mm. beyond the end. This holds the radium tube in place and affords a soft rubber tip for the applicator, which will prevent undue trauma. It may be used similarly as the applicator shown in Figure 5, No. 2, but its extra bulk limits its application. It is the one of choice in treating a bulky tumor with a sinus of the rectum. With the index finger it can be easily directed through a tortuous canal common to bulky tumors.

The applicator (Fig. 5, No. 1) can be introduced easily. It is very efficient in the treatment of the deep end of the distal colostomy loop; if used in this way, the brass filter is added (Fig. 4, No. 1). The wire stem permits easy introduction and secures fixation to the body surface.

The instrument shown in Figure 4, No. 6 is a modification of the soft rubber

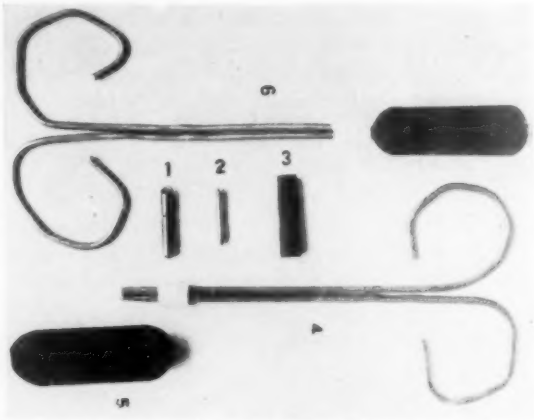

FIG. 4. No. 1. Universal silver filter with walls 0.5 mm. thick. No. 2. Modified Universal tube applicator; the walls are brass. No. 3. A rubber filter with wall 3 mm. thick. No. 4. A stem of solder wire 40 cm. long, with a small piece of adhesive tape around the tip to keep the stem from slipping through the canal in the rubber filter. No. 5. Part of a soft rubber Wales bougie (No. 10 or 12). The window accommodates one Universal tube applicator with or without the brass filter. No. 6. A modification of the soft rubber Wales bougie.

rectal Walles bougie. The unmodified bougie is very uncomfortable to wear for

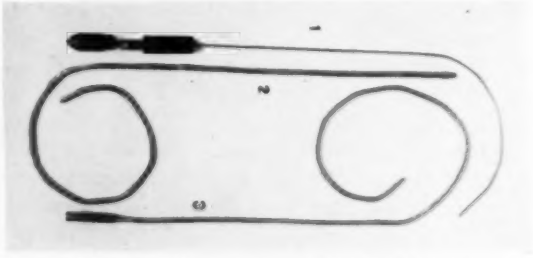

FIG. 5. No. 1. Wire stem and hard rubber tip with walls 2 mm. thick, into which the Universal tube applicator fits, with or without the extra brass filter. No. 2. A stem made of solder wire measuring 3.5 mm. in diameter and 40 cm. in length. The screw adapter at one end fits the applicator shown in Figure 4, No. 2. No. 3. A stem of solder wire. A brass shell is fixed at one end devised to fit the Universal tube applicator, and a Para rubber tube extends 5 to 8 mm. beyond the end of the tube.

any length of time. Some patients will not tolerate it at all. It does not permit accurate introduction, since the index

finger cannot be placed in the rectal canal at the same time.

The length of the part (Fig. 4, No. 5) may vary to suit the tumor, but if it is 6 cm. long, it is convenient, since it can be moved along the surface of the tumor. A strip of adhesive plaster is placed around the rubber part and then fixed to the stem; this makes a rigid applicator. The rubber filter (Fig. 4, No. 3) fits the window and is intended to absorb the soft secondary rays from the metal tubes. A finger cot placed over the end and fixed with adhesive tape completes the instrument. This

In the treatment of inguinal glandular enlargements, a wood block (balsa) 2.5 cm. thick and 3 by 4 cm. at the base is used to maintain the distance. Two millimeters of lead and 2 mm. of Para rubber are employed as filters. Fifty or 100 mgm. of radium in a Universal tube applicator is fixed to the block and allowed to remain twenty and ten hours respectively. The skin surface is mapped out in areas 3 by 4 cm. and from 3 to 6 areas are exposed in each inguinal region.

Radium can be buried in the tumor or ulcerated area. The standard metal needles,

FIG. 6. A vaginal applicator which accommodates two Universal tubes. The brass wall is 1 mm. thick and is surrounded by 2 mm. of hard rubber. The outside diameter is 17 mm. and the length 4 cm.

FIG. 7. No. 1. A spinal puncture needle, the end of which has been milled to fit the tube. No. 2. A brass tube made in various lengths, 20 to 40 cm. No. 3. A wire trocar long enough to dislodge the glass tube.

applicator is very easily tolerated by the patient. It can be accurately placed with the index finger and securely fixed to the body surface. It is suitable in the treatment of small bulky growths and tabular growths which do not completely encircle the bowel.

The applicator shown in Figure 6 holds two Universal tubes. Friction holds the cap in place, and a finger cot covers the whole. Similar applicators have been in use for three years and have proved to be very satisfactory. Its chief use is in vaginal applications. It is placed with the patient in the knee-chest position and the distended vagina is packed with gauze; thus a minimum of normal tissues is radiated. It can be placed in a wide open wound of a posterior resection and held there with packing.

with walls 0.4 mm. thick, may be used, or bare glass tubes containing radium emanation taken from a Duane series of mercury pumps. An instrument is being perfected to facilitate the placing of the steel needles by direct and indirect methods. They may be placed by direct vision through a proctoscope or by the use of a brass cannula of sufficient size. The method of choice is by bare glass tubes.

Figure 7 shows the instrument employed in the bare glass tube technique; it consists of a needle (Fig. 7, No. 1), a brass tube (Fig. 7, No. 2) and a wire trocar (Fig. 7, No. 3) of sufficient length to dislodge the bare glass tube. If the needle and tube are made to be interchangeable, needles can be kept sharp, which is very important.

In burying the radium, general or local anesthesia is required. If the needles are

few in number and the mass small, the treatment is preceded thirty minutes by a hypodermic injection of $\frac{1}{300}$ gr. of scopolamin and $\frac{1}{6}$ gr. of morphin sulphate. Other anesthetic is not necessary. A general anesthetic is seldom used.

If our observations from treating the inoperable growths are correct, the operable growths should be exposed to radium, and after sufficient time has elapsed, probably six or eight weeks, the tumor area should be removed.

FIG. 8. (Case A100372). Specimen removed at operation.

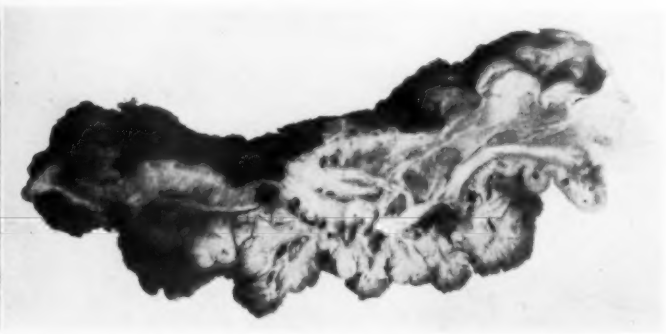

FIG. 9. (Case A100372). Longitudinal section of specimen shown in Figure 8.

"Surgical judgment" is not acquired in a few months, and may not be acquired for years; this is also true of radium therapy. The problems of the radium therapist are many. The patient, as well as the disease, must receive consideration. Should

Figures 8 to 11 show good examples of the lesions encountered in this group. The mass (Figs. 8 and 9) protruded into the lumen of the rectum, causing partial obstruction. It would be possible to bury radium needles in this bulky tumor.

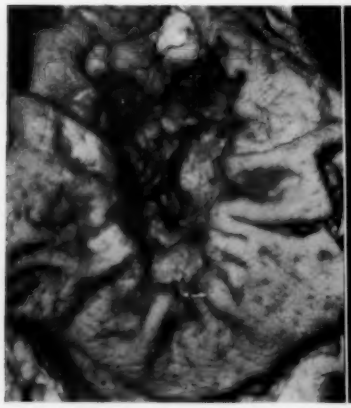

FIG. 10. (Case A170796). Specimen removed at operation; partial involvement of the walls of the rectum.

FIG. 11. (Case A170796). Cross-section of specimen shown in Figure 10.

the patient's health be greatly undermined on account of the disease or weakness following surgical procedure, the treatment is usually reduced in the number of applications. Each group furnishes its own problems.

The various types of tumors occurring in Group 1 require the widest range in technique. All buried radium treatment should be preceded by surface treatment. The extent is measured, and if it is within 4 to 7 cm., three treatments are outlined

and recorded as high, middle, and low positions. The applicator used may be the one in Figure 4, No. 6, or, in Figure 5, Nos. 2 or 3. Fifty milligrams radium is allowed to remain in each position for fourteen hours at one or two day intervals. If growths are small, brass filters should be used; otherwise, they are omitted. The majority of the 22 patients were operated on within ten and fourteen days after the first treatment. Definite gross changes in the tumor and edema in the tissues were noted, and the incidence of infection was suspected to be rather high. In order to manage the patients in this group more satisfactorily, more time (at least four to six weeks) should elapse, after the first treatment and before operation. This interval is essential in order that the treated area may heal and the tumor tissue be replaced by fibrous tissue. All overradiation should be avoided. These cases require keen judgment and close cooperation between surgeon and radiologist.

If bare glass tubes are placed, the technique of Janeway is used. Tubes measuring 0.5 mc. are preferred. If the tumor is thoroughly radiated in this way, the results will be more certain.

In the inoperable group, Group II, the number of applicators is usually limited; the one of choice is that shown in Figure 5, No. 3. The canal through the tumor area is usually small and tortuous. The number of levels treated depends on the extent of the growth. Extensions in the region of the rectosigmoid area are the most tedious to expose, and these are usually undertreated. Three to four areas are the rule and are designated as high, middle, and low positions for application. Fifty milligrams is usually applied for fourteen hours in each area. A colostomy is not essential for this treatment, if, by abdominal exploration, the borderline case is found to be inoperable, and without obstruction. In some cases, the treatment will reduce activity and avoid impending obstruction. In this manner, the patient may get on without a distressing colostomy; however, an early colostomy is paramount in case obstruction develops. The most striking cases in this group are the ones made operable by radium treatments. Early metastasis is not a characteristic of cancer of the rectum, and if reduction in the tumor occurs, posterior resection should be performed. The time interval should be six to eight weeks. All the patients in our series were thus treated. In cases reported in the literature, longer applications were made and more radium was applied. Our policy has been more conservative, and our local reactions are less. If the radium applicator can be placed in the center of a bulky growth, more radium and longer application are indicated. Overradiation should always be avoided, and possible surgical difficulties prevented.

Group 3, the recurring group, should continue to grow smaller. All patients operated on, and particularly those not previously treated, should receive postoperative radium and roentgen-ray therapy.

The applicator shown in Figure 5, No. 1, and the vaginal package (Fig. 6) are best suited to cases in Group 3. Brass filters are essential in the absence of the tumor, which is usually made use of to absorb the soft primary and secondary rays. Fifty or 100 mgm. tubes are used. The number of applications depends on the size of the cavity to be radiated. Three to five is the rule. The time is usually ten to fourteen hours. The vaginal package is fixed to a cord which aids in the removal, and is held in the Kraske wound with gauze packs. The interval between applications is two or three days.

All patients should be under observation. The treatments may be given at intervals of six and eight weeks, for the first six to eight months after operation. Every possible aid should be employed to establish a diagnosis of recurrence on account of a possible inflammatory process.

The primary growth in the rectum is but slightly affected by the roentgen ray. Even the newer apparatus, with voltages of 200,000 or more, gives disappointing results, and so we must look to radium for destruction of the primary lesion. On the other hand, metastatic nodules and lymphatic tissues are more susceptible to the roentgen ray.

The object of the roentgen-ray treatment is (1) to destroy or decrease in amount the lymphatic tissue and thus

decrease opportunity for metastasis, (2) to destroy or inhibit the growth of metastatic nodules.

The cases reported in this group were treated by the old technique, which consisted of a 23 cm. skin-target distance, filters of 3 or 4 mm. of aluminum, a spark-gap of 23 to 24 cm. between blunt points, and a current of 5 ma. sent through a broad focus standard Coolidge tube for five or six minutes. This formula produces a transient erythema in the skin, and at times causes slight pigmentation.

The rays were directed to the pelvis through 9 portals of entry, namely, 4 anterior, 4 posterior, and the perineum.

This method produced a somewhat effective cross-fire for the deep glands, and radiated the superficial glands, such as the inguinal and the perineal groups.

If these superficial lymphatic glands were definitely involved, they were treated with radium.

FIG. 12. A simple rubber stamp for the recording of accurate data. The dotted portion shows the extent of the involvement, height of lesion and rectal walls involved.

In the technique now employed, advantage is taken of the fact that a long skin-target distance assures nearly even distribution of radiant energy in the superficial tissues, and a large quantity of energy available for absorption in the deeper tissues. Nearly homogeneous radiation of short wave-lengths is obtained by copper filtration and higher voltages.

The general reactions which usually follow the surface applications of radium and roentgen rays are similar to those seen in the treatment of other conditions. They are, as a rule, a mild degree of anorexia, nausea, vomiting, and weakness. This lasts for twenty-four to forty-eight hours, and gradually disappears. The local reaction is tedious to evaluate. Some patients complain of an increase in mucous discharge, with or without blood, and very little, if any, increase in pain. Urgency, frequency, and painful urination are seldom complained of. Proctitis rarely occurs. The technique, as described here, is very conservative, and severe local and general reactions are rare. In the buried technique, general and local reactions remain the same, although, on account of the impossibility of maintaining a sterile technique, infections occur. Ordinary cleanliness, enemas, irrigations, etc., are the only method, of preparing the field for the introduction of the needles. Fever of 102 to 104° F. has occurred, with the other usual signs and symptoms of general toxemia. Local peritonitis has occurred. The local complication may be hemorrhage and perineal abscesses. Mild hemorrhage is expected, and if severe, the rectum is packed with vaselin gauze through a proctoscope from the rectal side and if bleeding is from the distal colostomy loop, a long proctoscope, small in diameter, is placed in the loop and fair exposure is usually obtained. Vaselin packing may be introduced in a similar way as from below. The packing is removed in forty-eight to seventy-two hours. The patient is supported with the ordinary methods to control hemorrhage.

It is essential that accurate records should be kept. Figure 12 shows the possibility of a simple rubber stamp. It is self-explanatory.

SUMMARY

1. Radium, if properly applied, causes a definite inhibitory and destructive effect in the majority of neoplasms of the rectum.

2. Sufficient evidence is available to prove that radium is a valuable adjunct when added to our present surgical measures in the treatment of cancer of the rectum. The closest cooperation between surgeon and radiologist is essential.

3. In order to give the best possible individual treatment and to avoid discredit of either surgery alone or surgery and radium and roentgen-ray, an abdominal exploration should be made, except in gross inoperable cases.

4. Following exploration which determines inoperability with little or no low obstruction, it is not essential to make a colostomy in order to give the radium and

roentgen-ray treatment as outlined. Observation at intervals of from six to eight weeks is essential for the purpose of determining the advisability of radical operation.

5. The majority of patients with gross inoperable lesions should be given the benefit of radium and roentgen-ray therapy. A colostomy should be made at the first sign of impending obstruction.

6. The majority of patients receive inadequate treatment. It is impossible to give intensive treatment to some patients because of their general condition and because the entire tumor cannot be exposed. In patients with a colostomy, the growth should be treated through the distal loop. If the mass can be palpated by digital examination of the vagina, this cavity should be packed with radium in close proximity to the rectal tumor.

7. Early diagnosis is paramount. A digital examination should be made routinely of all patients. An early proctoscopic examination by an inexperienced physician is better than a late examination by a proficient proctologist. Microscopic examination is of definite value in early cases and will help to classify the cases, as well as to furnish a basis for prognosis when patients are operated on.

8. Some neoplasms of the rectum respond readily, while others are resistant to radium and roentgen rays. Long survival is possible in untreated cancer of the rectum. Our conclusions must be guarded until a large series of cases is available and sufficient time has elapsed.

9. Since radium in larger quantities and high voltage roentgen-ray equipment are at present available, a combination of these is the most ideal method for radiation therapy, and results should be better.

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POSSIBLE DANGERS IN CONNECTION WITH THE USE OF X-RAYS AND HOW TO AVOID THEM

BY JOHN S. SHEARER, PH.D.*

ELECTRIC shock is due to an electric current passing through a portion of the body. The seriousness of such shock to the individual will depend on the part of the body traversed by the current, on its amount and duration and on the physical condition of the individual.

Data with reference to the amount and duration of current that would give a dangerous shock is somewhat limited, but it is certain that a small fraction of an ampere may be fatal if maintained for even a brief period.

In order to pass an electric current through the body, *two* areas of contact must be established between two points on an electric circuit that are maintained in different electrical states. We indicate this difference in condition by saying that they are at different voltages, or that a certain voltage exists between them.

The current passed will *increase* with the voltage difference and decrease with the resistance of the portion of the body included between the contacts. The resistance of the body may be as low as a few thousand ohms, and is very much less when the skin is moist than when it is dry.

Deaths due to circuits where the voltage between contact areas is less than 500 volts are rare, but they have been reported on as low as 80 volts; so that any voltage capable of operating an *x*-ray tube is well above any lower danger limit, and offers opportunity for fatalities.

In order to maintain an electric current, one must provide a means of maintaining voltage, as a flow of current invariably tends to reduce voltage. Thus, one may charge a small Leyden jar to several thousand volts and pass its discharge through the body without injury, as there is only a *momentary* current and the voltage lost is not replaced by a generator. On a large battery of such jars, this brief current might be so large as to cause serious injury or death.

We are mainly concerned with high voltages between conductors where current is supplied by generators wholly or in part maintaining the voltage. Any such circuit is potentially dangerous, and to a degree depending on the maintained voltage.

Since such circuits must be used, we depend on insulation or on insulators to prevent a conducting contact with the body.

An insulator is a piece of material that will prevent the passage of an appreciable current when two points thereon are maintained at a given voltage difference. There are no perfect insulators, and we consider insulating power as ability to prevent the passage of any appreciable current at the highest voltage to which the insulator is likely to be subjected. Thus if one applies 1,000 volts to an insulator having a resistance of 10,000,000 ohms, only one ten-thousandth of an ampere will pass. Insulators often rupture under high voltage, and also in many cases acquire surface conductivity. Thus, glass, when clean and dry, is a fairly good insulator, but when a layer of moisture (especially when this is slightly acid) is present, its insulating power is greatly reduced. Insulation must be designed and used with reference to the voltage to which it is to be subjected. Thus, complete insulation for 500 volts may be of little service for 15,000 volts.

Electric shock is due to *flow* or movement of charge, *not* to its presence. One may become charged to a high electric voltage and be quite unconscious of the fact, if the charging is done *slowly;* also, a *slow* discharge will give no sensation. In order to have a continuous flow of current through the body, we must have two points of contact with more or less conducting bodies between which there is maintained a tendency to drive electricity, i.e., a voltage.

The maintenance of voltage is due to generators of various types, and those voltages high enough to be dangerous are usually secured by transformers in cases where *x*-ray tubes are operated.

* Professor Shearer died May 16, 1922.

As a general rule, our bodies are in more or less conducting connection with the earth, which, due to moisture and large size, is a fairly good conductor. Also, generators and transformers are often connected at one point to earth, or "grounded," and, in general, are only insulated at other points for voltages somewhat in excess of their maximum operating voltage. Contact by the body with a non-earthed point on the circuit will offer the current a choice of paths between the contact point and the grounded point, either through the body or along the usual path. Some current will take the former path, and it remains to consider when danger arises.

Let us assume that a maintained difference of potential of 200 volts between two points on the body is dangerous, and see under what conditions we may have such a voltage. A higher voltage might have been chosen, but the principle is the same.

Consider a generator that maintains a voltage of 2,000 volts between its terminals when supplying current to a line of 400 ohms' resistance, one terminal of the generator being grounded (Fig. 1).

The large conductor AB shown is at no voltage above the earth. C_1 is 2,000 volts above or below earth, and C_2 is 250 lower than C_1, or 1,750 above earth. A person having connection with the earth and touching C_7 would have one point of his body at 500 volts above another, and might be injured. He could probably touch a point between C_8 and B with safety. If insulated, he could safely touch any one point between C_1 and B, but must not touch two at once, between which a dangerous voltage exists, as say C_4 and C_7.

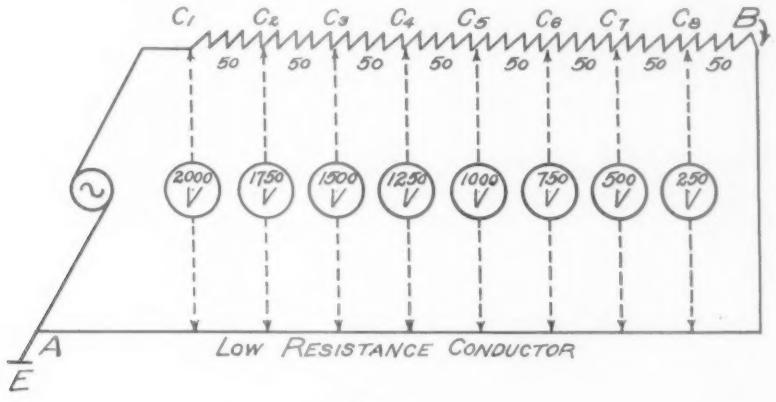

FIG. 1.

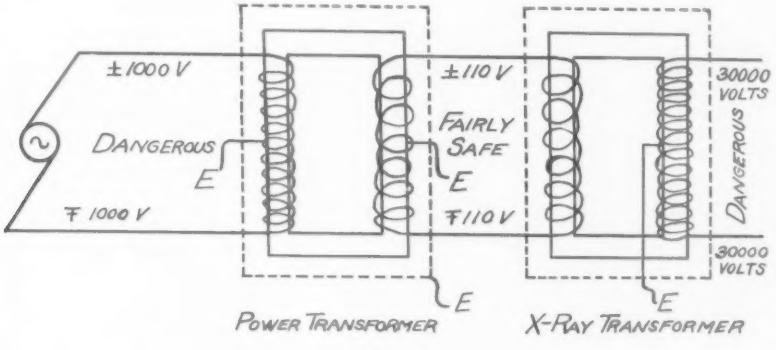

FIG. 2.

Generators furnishing AC current at voltages above 500 volts are not wired directly to house lines, but to transformers that "step down" the voltage. This is again "stepped up" for *x*-ray operation.

Figure 2 shows such a line and regions of danger where a grounded middle is used.

No part of the 2,000 volt line is safe for a person grounded, except the middle of the primary, which may be safe if connected to the case or earthed. Any part of the line between the two transformers is reasonably safe. None of the *x*-ray secondary except its middle point can be regarded as free from danger.

Most *x*-ray transformers have their secondaries wound in two, four, or more sections and the middle of the system connected to the metal transformer case. This may be earthed, or simply stand on a more or less conducting floor. In either case, when one comes in contact with the high tension line, there is an opportunity for current to pass through the body to the floor, and thence to the middle of the secondary. The amount of this current for a given line voltage will vary greatly with the resistance of the support on which the person is standing. If the floor is highly insulating, the current will be too small to be troublesome; otherwise it may be very dangerous, or even fatal. Concrete and tile floors are fair conductors, especially when moist. Wood floors may have nails reaching or near conducting material. Figure 3 shows the circuits in this case.

On contact with the line, one-half of the transformer secondary becomes effective driving current from the outer terminal through the body to earth and back to the middle point of the secondary.

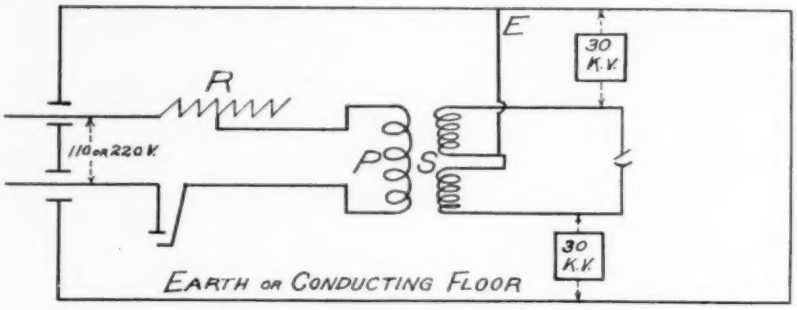

FIG. 3.

When one secondary terminal of the transformer is grounded instead of the mid-point, all parts of the line between that terminal and the tube will be safe to touch so long as the ground is maintained. However, for the same operating potential the ungrounded terminal will be twice as dangerous, or at least would pass twice the current over the same resistance as before, and would be twice as likely to spark over.

This construction is frequently used with the right-angled dental tubes operating on rather low voltage. It then renders the terminal nearest the patient safe, and makes proper separation from the other

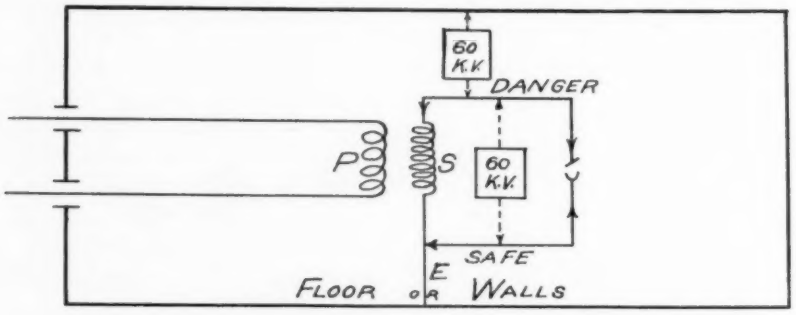

FIG. 4.

line imperative. This construction should not be used for ordinary 5-in. gap outfits.

Clearly, the only entirely safe procedure is either to insulate completely *all* parts of the high tension circuit, as when transformer, line and tube are all immersed in oil, or to insulate operators and patients so that contact between points of dangerous voltages is impossible. Probably neither of these can be fully carried out for all work at present, but much can be accomplished to reduce danger, even in old installations.

Nature of Accidents Reported. A survey of reported accidents may be classified as follows:

1. Accidental closure of low tension switch.
2. Short circuit of foot switch or locking in position.
3. Leaving low tension switch closed and attempting to adjust tube or reels.
4. Coolidge filament wires hanging too low.
5. Breaking of reel wire and the end attached to the tube falling on the patient.
6. Attempting to set a double scale milliammeter when operating switch is closed.
7. Failure of high tension insulators.
8. Crossing of high and low tension lines.
9. Failure of insulation of low tension circuit.
10. Bringing the tube too close to the patient.
11. Leaving wires too close to the patient.
12. Spark-over due to surge.
13. Failure to shift high tension switch to proper side before closing primary.
14. Breaking of overhead line.
15. Attempting to measure spark-gap with a ruler when power is on.
16. Discharge to diaphragm control due to slack reel wire.
17. Break in primary insulation cutting out part of the control and thus causing unusually high voltage.
18. Unusual spark-over due to failure to close filament circuit on a resistance controlled machine.
19. Contact with unused connectors or reels, sometimes in rooms where one has no information as to whether high tension is on or not, viz., fluoroscopic room separate from the radiographic, and operated by a transformer in the latter—a dangerous practice.

Of these various accidents, all were painful and some were fatal. While those enumerated do not exhaust the possibilities, yet if their chance of occurrence were minimized we should have accomplished considerable toward making outfits electrically safe.

1. Would not occur if it were necessary to perform two *voluntary* acts each time an exposure is made and *all* switches were self-opening. Thus a latch device that has to be held out before a switch can be closed, and a spring opening the switch when the hand is removed would make closure deliberate in all cases. Push-button switches should have a stop making pressure at two points necessary for operation.

2. No foot switches should lock closed, or have such weak springs as will permit a slight pressure to close them. All breaks should give a clearance large enough to avoid possibility of arc or accidental bridging.

3. Would not happen if the suggestions in No. 1 were adopted and the operator was obliged to stand where there is a full view of the tube, patient and high tension line. Lead glass windows, if used, should be large enough to permit such a complete view.

4. If overhead tubing is used, Coolidge wires should be drawn inside of one tube and reels should be firmly supported.

5. The flimsy reel wire, often only tinsel, so commonly used, is inexcusable. A braided tube over a twisted center made up of very fine *enameled* copper wire is at once strong and flexible.

6. No double scale milliammeters should be permitted. For treatment a 0 to 10, for radiography a 0 to 100 scale covers all needs. This would avoid danger of changing during operation and of treating with an improper scale setting.

7. A noteworthy example of this was seen where a hard rubber insulator passed through a lead box on a vertical fluoroscope. The fluoroscope was mounted on wooden castors. The lead was left sharp edged around the rubber and by corona

action finally broke through. The discharge passed from the lead box to the metal diaphragm handle to the observer and thence to the floor. Micanite tubes, or hard rubber tubes with a thin inside metal tube would prevent such an accident.

8. This means improper installation or loose wires hanging where contact is possible.

9. A switch opening only one side of the power line was opened under conditions giving a heavy surge. This broke through the primary insulation in such a way as to leave a small primary current still passing. All circuit breakers and switches should break both lines, i.e., be of the double pole type.

10. No arrangement of ordinary apparatus will protect a patient from a careless operator.

11. Same as 10; reels should always keep wires taut.

12. This may exceed ordinary operating or spark-gap voltage.

13. Only one connection should be possible at one time and the operator should be able to close the circuit only when in a given position.

14. Poor construction to be avoided.

15. A careless procedure. A well insulated handle and a proper scale should be provided.

16. Poor reels, or worn covering. See reel wire above.

17. May give a much greater voltage than intended.

18. On large machines the Coolidge filament should light when the motor switch is closed.

In cases 1, 2, 3, 13 and 14 there is a chance of a person's coming in contact with both high tension lines, and it is immaterial whether or not he is insulated. In all cases where contact would be at one point only, an insulating floor would be a great safeguard.

Special attention should be given to portable, bedside and dental machines, where the high tension lines are, or may be, dangerously close to operator or patient. It must not be assumed that low power transformers are safe; they may, as stated above, be especially dangerous. The facts that these outfits are of necessity so compact, must often be operated in very limited space or adjacent to other apparatus and in proximity to nurses, and often on bedridden patients, make it imperative to render them as safe as possible, and then to insist on great care in their operation.

Foot switches should never be used with these machines on account of the danger of their closure by accident while the tube is being adjusted. The high tension wires should run vertically upward at least to the level of the tube, and pass through insulating tubes of mica or hard rubber to a height several inches above the level of a bed. All the high tension wires should be as far away as possible and must be kept taut. They should have a quick acting circuit breaker set as close to the normal operating current as possible. Switches should be self-opening and should require two movements for their closure.

The practice of making dental radiographs in the usual metal dental chair is a constant source of danger. Such work should be done in wooden chairs that are well insulated.

Considerable discussion has arisen in connection with grounding parts of *x*-ray installations, and there seems to be an idea prevalent that if only grounds enough are provided, all else may be neglected. This doubtless arose, in part, on account of the grounding of conduits, transformer cases, motor frames, etc., in wiring practice. If one could never touch any *ungrounded* portion of the circuit, safety would be certain, but if one does touch a high tension line, then contact with a grounded floor or support is a *source* of danger. Note the number of cases where electrocution has resulted from contact with rather low tension circuits when a person was in a bath tub, standing on a wet cellar floor, or with wet shoes against a radiator. Here the victim was between a line above earth potential and the earth. A lineman does not ground himself, if he can avoid it, when he repairs a moderate, much less a high voltage line; rather he wears insulating gloves. Also good wiring rules do not permit placing a metal lamp socket in a cellar or near enough to a bathtub to be reached by the occupant. Porcelain sockets

with porcelain-covered keys are used in such places. Grounding never secures as complete immunity from danger as does complete insulation. No one denies the desirability of grounding certain things, but we must not delude ourselves that no discrimination is needed, for the improper use of grounded conducting material may increase rather than decrease danger.

Testing. A few simple tests may assist in determining whether installations are reasonably safe or not:

1. What regions are in danger of spark-over to operator or patient? Place a metal plate or water in a metal pail on the floor. Insulate a milliammeter and connect one terminal to the plate or the water, fasten a piece of flexible wire to a dry stick about three or four feet long and approach it to various parts of the apparatus when in operation. The spark distance and the milliampere reading will give a fairly good idea of the danger if the body replaced the wire.

2. Test overhead systems by hanging a weight on the middle portion considerably in excess of the pull of the reels when fully extended.

3. Milliammeters in series should give identical readings. This test is easily made.

Line leakage in therapy can be tested by putting one milliammeter close to the tube and the other close to the transformer. When a meter near the transformer reads 5 ma., and .5 ma. less near the tube, the error is considerable. Leakage is always greater at higher voltages.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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REPORT OF THE SAFETY COMMITTEE PRESENTED AT THE LOS ANGELES MEETING OF THE A. R. R. S.

This report covers only one phase of the subject assigned to this Committee for study, namely, the danger from high tension shock. In formulating our report, we have thought it advisable to make the following recommendations. A preliminary discussion of the subject by the late Professor Shearer will be published in the JOURNAL.

1. *X*-ray equipment should not be installed or operated in low-ceiling rooms with overhead piping, or in damp or poorly ventilated rooms.

2. Floors should be covered with cork or other insulating material.

3. Footswitches should not be used in any radiographic work.

4. All diagnostic operating switches should automatically and positively open when released.

5. Double scale milliammeters should be eliminated.

6. Two milliammeters in series should be used in treatment.

7. All *x*-ray apparatus should be equipped with quick acting circuit breakers, preferably of double pole type. These should open with certainty on a 20 per cent overload. Circuit breakers should be tested at least once a month and a permanent record kept of these tests. Properly rated fuses should be used in addition to circuit breakers.

8. Where overhead high tension lines are used they should be of metal tubing not less than ½ in. in diameter. They should be firmly mounted and extend to the transformer or rectifier terminals.

9. High tension reel wire should be of fine braided enameled copper without cloth covering, strong enough to stand a pull of not less than 50 lbs. weight.

10. High tension reels should be firmly mounted and have proper winding guides to prevent catching when winding, and sufficient tension to wind up against a pull of 1 lb. weight.

11. Vertical and horizontal fluoroscopes should be so enclosed by insulating materials as to prevent operator, patient or assistants from approaching within sparking distance of any part of the high tension system. Metal screens should not be used if the fluoroscope table permits the use of a tube *over* the patient.

12. In every installation the operating switch should be so placed that a full and unobstructed view is had of the high tension line to be used. If lead glass windows are provided, they should be large enough to insure such a view.

13. All tables used for treatment with the patient between the tube and the table should be made of insulating material, unless the tube and terminals are enclosed in a permanent grounded case. No spring mattresses should be allowed.

14. Tables used for radiographic and fluoroscopic work should be of insulating material when practical, and the handles of all switches and diaphragm controls should be of such material.

15. Where tubes in more than one room or booth are to be operated from the same transformer, provision should be made so as to make impossible simultaneous operation or closure by anyone not in direct

charge of the tube or line used. This may readily be accomplished by suitable interlocking switches or otherwise.

16. All bedside or portable outfits should have their high tension lines so placed that they permit of doing bedside work without having their wires come nearer to the patient than the tube terminals.

17. No treatment apparatus should permit any part of the high tension system to come closer to the patient than double the operating spark-gap, unless protected by a suitable insulator.

18. *Permanently* placed grounded metal screens between the tube and the patient are permissible and advised where the spark-gap exceeds 10 in.

19. Machines for high voltage therapy should be so designed that their milliamperage on a short arch discharge is not more than 50 ma.

In conclusion, the Committee recommends that in view of the constant and rapid changes taking place both in the application of *x*-ray and in the manufacture of apparatus, a Board be appointed to which questions having to do with the dangers incident to the use of radiation of short wave-lengths and the apparatus used to produce them, can be referred. It has seemed to this Committee that this subject is too large and is changing too rapidly to be covered in any one report, and that it would be better to take up individual problems as they arise.

Respectfully submitted,
G. W. Holmes, Chairman.
P. M. Hickey,
W. D. Coolidge,
H. K. Pancoast.

THE DOCTOR SOFIE A. NORDHOFF-JUNG CANCER RESEARCH PRIZE

Dr. Sofie A. Nordhoff-Jung of Washington, D. C., U. S. A., has founded an annual prize of five hundred dollars bearing the title, "The Sofie A. Nordhoff-Jung Cancer Research Prize." This prize is destined for the encouragement of researches in the etiology, prevention and treatment of cancer. It will be awarded by a commission composed of members of the University of Munich, Bavaria, and be granted for the first time in December of the year 1923. The commission consists of Professors Borst, Doederlein and Sauerbruch, with Professor von Romberg as chairman. This body is empowered to elect successors. The award will be made as a recognition of the most conspicuous work in the world literature bearing on cancer research, done at a time antecedent to the allotment of the award. Though the prize will not be awarded on a competitive basis, the commission invites all research workers in cancer to submit literature on this subject.

A COMPLETE EXAMINATION OF THE CHEST

Does practice make perfect? In relation to the clinical examination of the chest, we certainly hesitate to assert that it does. It is a frequent experience, in certain types of cases, to doubt one's sense of hearing and touch. There comes a time in every honest clinician's experience when varying and not necessarily complex changes in the lungs puzzle, confound and discourage him. The simplest cases are frequently the most difficult to interpret, and often after failing to diagnose correctly through the sense of touch and hearing, a period of discouragement ensues.

Specialists in chest diseases have as yet failed to see the enormous value of fluoroscopic and radiographic examination. They have, to a large extent, failed to combine the sense of sight with the other two senses, and in consequence, have lost a tremendous moral support. The proper use of radioscopy does not conflict with or contradict other physical results. It is a constant education, and it increases the usefulness of the physician's hands and ears as well as his self-reliance. Unhappily, in the past, ignorance and prejudice have hurt both the chest specialist and the radiographer. The matter needs readjustment, that greater use may be made of the advantages of *x*-rays.

The function of the lungs depends upon changes within the thorax, and frequently, although a correct diagnosis of the disease

is made, the actual functional changes are not understood. Fluoroscopic examination to determine function is not so difficult to carry out and is a remarkably exact method. Without it, is a clinical chest examination, from the patient's point of view, complete? As a matter of record and for future study and comparison, the examination should include a fluoroscopic and radiographic examination. When the clinician becomes expert in this method a good deal of prejudice will fall by the roadside. In that day the saying, "Practice makes perfect," will be more truthfully applied to the examination of chest diseases. JAMES A. HONEIJ.

AMERICAN RADIUM SOCIETY

EIGHTH ANNUAL MEETING

The American Radium Society will hold its eighth annual meeting at the Civic Auditorium, San Francisco, Calif., on Monday, June 25, and Tuesday, June 26, 1923. A program of unusual interest and merit will be provided and it is to be hoped that all interested in this virile subject will make a special effort to attend. The American Medical Association is holding its meeting at San Francisco this year, and thus it will be possible for one to attend the meetings of the two societies. The headquarters of the Radium Society will be the Hotel Whitcomb. This is the first time that the American Radium Society is holding its meeting on the coast, and it is worth remembering that there are things medical in that section of the country which are well worth seeing. Besides, there are atmosphere, scenery and other things.

THE LEONARD PRIZE

The American Roentgen Ray Society is again offering the Leonard Prize in 1923, details for which appear on advertising page iii of this number of the JOURNAL. The manuscripts submitted for the 1921 prize were of a high order of merit and covered a variety of subjects pertinent to roentgenology. It is to be hoped that the contestants for the next prize will be equally zealous in their efforts.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY *visiting New York City, are invited to make the office of* THE JOURNAL (*69 East 59th Street, New York*) *their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

TRANSLATIONS & ABSTRACTS

STOKES, JOHN H., AND BROWN, PHILIP W. Two Hundred Syphilitic Patients Whose Chief Complaint was "Stomach Trouble": An Interpretative Analysis of the Diagnosis of Syphilis in Consultant Medical Practice. *Am. J. M. Sc.*, Dec., 1922, clxiv, No. 6, 867.

In the course of this article, the authors give some extremely interesting statistical data concerning gastrointestinal symptoms in cases of syphilis. In a series of 200 patients, there were 35 on whom needless operations had been performed, because of various aspects of syphilis leading to the complaints of stomach trouble. On the other hand, there is a group of patients who present a problem in which the surgeon should have the right of way over the syphilographer. The authors recommend that when, after a very careful study, the question of malignancy is raised in the face of a concomitant syphilis, the most important move is the surgical exploration, which will clinch the diagnosis and afford the patient the promptest and best prospect of relief. On the other hand, patients with inoperable, or presumably inoperable, abdominal malignant lesions, from whom a suspicion of syphilitic infection can be obtained, should be given the benefit of treatment for syphilis. In the list of 200 syphilitic patients studied, test meals were given in 122 cases and roentgenological study made in 131. The roentgen examinations were negative in 110, 11 had duodenal ulcer, 1, gastric ulcer, 1, cardiospasm, 4, gastric syphilis, and 4, questionable pyloric lesions. The authors have observed striking symptomatic improvement in certain cases of gastric and duodenal ulcer in neurosyphilitic patients in whom the roentgen ray after treatment showed the lesion itself to be still present.

PLATT, HARRY. Pseudo-Coxalgia: A Clinical and Radiographic Study. *Brit. J. Surg.*, Jan., 1922, ix, No. 35, 366.

The author, in conjunction with his radiological colleagues, Dr. J. M. W. Morison and Dr. A. E. Barclay, here presents an extensive study of pseudo-coxalgia. This disease, otherwise known as osteochondritis deformans juvenilis coxae, is a definite entity representing the reaction of the metaphyseal region of the upper end of the femur to the stimulus of an infective agent of attenuated virulence. The condition is comparable with the arthritis deformans juvenilis coxae which is seen solely in adolescents, and which represents at this age period the reaction of the hip-joint to an infective agent of a similar type. The whole cycle of radiographic changes is peculiar to pseudo-coxalgia alone. They precede and outlast the clinical phenomena. The final picture is dominated by the deformation of the head of the femur, which is enlarged and flattened. The acetabulum in its final form can no longer contain the whole of the expanded head. Deformation of the head of the femur with flattening and expansion is seen also in conditions distinct from pseudo-coxalgia during childhood. There is no evidence to show that in these conditions the typical structural osseous changes of pseudo-coxalgia have preceded the stage of flattening. At certain stages the clinical and radiographic pictures of the two groups of affections may show considerable resemblance. This applies particularly to cases of primary tuberculous osteomyelitis of the femoral neck. In the conditions known as tarsal scaphoiditis (Köhler's disease), and apophysitis of the tibial tubercle (Osgood-Schlatter's disease), bony changes parallel to those in pseudo-coxalgia are found. Conservative treatment directed toward the elimination of weight-bearing has no proved influence on the train of morbid changes, but its application is indicated during the stage of prominent symptoms. Operative treatment directed toward the removal of the dominant lesion has no present place in the therapeutics of this disease.

The article contains a very complete discussion of the radiological findings which should be referred to in the original by radiologists who wish to consult with authoritative work.

WHITE, J. RENFREW. A Case of Multiple Pulsating Bone Tumors. *Brit. J. Surg.*, Jan., 1922, ix, No. 35, 458.

The author, after commenting upon the rarity of multiple pulsating tumors of bones, cites a case: Male, aged twenty-eight, suffering from painful swollen and stiff right knee, painful swollen right heel, varicose veins of right calf. Twelve months before, he had knocked his right knee with some violence against a counter. Ten months later he inflicted a further and more severe injury on the joint in a bicycle accident. Some three years earlier, the patient, while in military service, had some trouble with his right heel, which subsided; but eight months before the patient was seen (four months after the first accident to his knee) his heel again became tender and swollen. *X*-ray examination showed marked decalcification of all the bones of the foot, reaching a maximum in the os calcis, in which, indeed, actual cavity formation seemed indicated. The lower end of the femur showed a similar change, with signs of a recent pathological fracture of the condyles. A clinical diagnosis of tuberculous

disease was made. The femoral condyles were found to be expanded, and at several places, perforated by a very soft vascular friable tumor which had invaded the muscle, and, in places, the knee-joint. The tibial tumor was of similar structure. The patient underwent several operations, the first for scraping away granulations and resecting the walls of the cavity. The wound healed by first intention. The leg was maintained in a plaster of Paris cast. On November 23rd, the patient returned, complaining of pain about the middle of the leg. The knee-joint was swollen and pulsating visibly, and a marked systolic bruit was to be heard, over the joint, with a stethoscope. In the middle of the leg over the front of the tibia was another pulsating, fluctuating tumor, and over this, too, a loud bruit was audible. Radiologically, there was seen a complete solution of continuity of the shaft of the tibia—a spontaneous fracture. A high amputation was therefore done. Examination of the amputated limb showed the femoral condyles excavated, expanded, and, at several places, perforated, by a very soft vascular friable tissue, which had invaded the adductor magnus muscle and, in places, the knee-joint. The tibial tumor was of a similar structure and appearance, and had destroyed and replaced 2 in. of the shaft of the bone, without, however, having perforated its periosteal sheath. An incision into the heel and remains of the os calcis showed but ordinary scar tissue, and nothing to suggest a recurrence of the tumor growth. The final diagnosis was a sarcomatous formation corresponding to an alveolar sarcoma.

CHERRY, THOMAS H. The Uses of Radium in Gynecology. *New York M. J. & Med. Rec.*, July 5, 1922, cxvi, 1.

This paper gives a brief outline of the uses of radium in gynecology. In the course of his remarks, the author states that all cases of uterine carcinoma are not fit subjects for radium therapy, any more than they are for surgery. When a large fungating carcinoma of the cervix with metastases is treated with radium, a tremendous amount of cell destruction takes place, with the consequent absorption of the products of cell disintegration. It is, therefore, necessary to ascertain if the organs of elimination can take care of this extra strain placed upon them. A thorough test should be made of the patient's general physical condition, including kidney function test, urinary findings, blood chemistry, hemoglobin and red cell count. If a patient with inoperable cancer, for example, has hemoglobin of 30 to 40, a 2,000,000 red cell count, and urine with albumin and casts, and with a phthalein output in two hours of 10 to 30 per cent, and blood chemistry showing carbon dioxide combining power of 25 to 40 per cent mgm. to 100 c.c. and a marked retention of urea nitrogen and creatinin, that patient is not a candidate for radium. First transfuse with whole or citrated blood, and then, if, after a time, the patient improves, radium therapy may be instituted.

PERTHES, G. Radiotherapy of Malignant Tumors. *J. de radiol. et d'électrol.*, March, 1922. *Radium*, July, 1922.

The author reports "the present actual state of roentgen therapy" on "broad lines" and limits himself to "three questions of particular importance."

First. At this time what part do *x*-rays take in healing malignant tumors? To what extent can they be taken into account in fixing therapeutic indications? Of the cases formerly treated surgically, which ones should we now submit to roentgen therapy?

In the beginning, he discusses only cases of operable cancer, and considers, along with the successes of *x*-rays, those of radium, because in spite of "irrefutable theoretical considerations on the basis of which massive homogeneous irradiations with strongly filtered *x*-rays are preferable to the more narrowly localized action of radium, practical experience has shown that better therapeutic results are obtainable with the combined use of radium and *x*-rays."

The observation that *x*-ray can bring about healing of cancers of the lip and of the skin, first made by Magnus Moeller in 1898, has been confirmed many times. Likewise have such good results followed radium therapy, and though there are opinions to the contrary, the results obtained in the treatment of both the prickle-celled and the basal-celled epitheliomata are equally good.

From the esthetic side the result is often ideal, and so superior to surgery. The idea that there has been only a superficial healing must be abandoned, because results over long periods indicate the contrary.

If the results obtained were uniformly good, roentgen or radium therapy would always be the preferred method. However, such is not the case, as, occasionally, though there is disappearance of the principal tumor, a portion is left which later proves unresponsive to the action of the rays, even though the treatment which obtained the earlier good results is repeated. Here, occasionally, radium will give good results, but some growths are refractory to it. In cancer of the lip, the "cures" after three years are about the same (80 per cent) with either surgery or irradiation. In treatment of cancers of

the lip and skin the author prefers irradiation, but warns that the patient be kept under careful observation. For cancer of the penis he prefers radium therapy, even more than for epitheliomata of the face and lip.

In cancer of the buccal mucosa and of the tongue, conditions are less favorable to both surgery and radiotherapy, and no cures have been observed with *x*-rays alone. Stricker reports, however, two cases of papillary cancer of the tongue cured four years after treatment with radium. The infiltrating type of lingual cancer is the least responsive, but combined with radium and deep roentgen therapy has given better results. Béclère has added to his translation Regaud's opinion that in view of the dangerous and mutilating results of surgical removal of the tongue, and the small number of cures, the continued investigations of radiotherapy are warranted here.

Though in cancer of the jaw some cases of healing by radium have been reported, the author believes that the improved surgical technique with its results is to be preferred.

In cancer of the larynx and pharynx, local healing may follow *x*-ray and radium therapy, but recurrences and metastases are frequent, and surgery must be resorted to.

Cancer of the esophagus is best treated by *x*-ray and radium, and though cures are not often the result, the relief to the patient warrants their use. In the stomach and intestine, surgery is still to be preferred. If some day radiotherapy is to be given preference, it will be first for cancers of the rectum. Of 5 cases treated in 1918, 3 have subsequently died, but two women were living and in good health about three years after treatment. The tenesmus passed away after a time.

Cancer of the breast can sometimes be cured by irradiation alone, one writer having reported 16.6 per cent and another 14.2 per cent of cures after three years, where no surgery was done. However, the surgical cure is better, and when the cancer is operable, surgery is to be preferred.

In treatment of cancers of the cervix uteri, combined *x*-ray and radium therapy is most often used, although remarkable results have been obtained by the use of *x*-rays and of radium alone. However, radiotherapeutic results have not surpassed the surgical, although many inoperable cases can be credited to radiotherapy. But most of the clinics claim best results in patients who have been rayed after operation, and in only carefully chosen cases, depending on the location, would this writer renounce surgery in favor of radiotherapy alone.

"Thus with the exception of cancer of the esophagus technically accessible to the knife but practically inoperable, we will send to radiotherapy only cancers of the skin, of the lip, and, under some conditions, but not always, cancers of the tongue; finally, cancers of the larynx above the vocal cords and perhaps with precaution, cancers of the rectum."

The greatest results from roentgen therapy have been in the inoperable cases, as in those of the breast. Cures are not often obtained, but the ameliorations are worth while.

There are, of course, exceptions to all cases, but the exceptions do not nullify the rule that even with the aid of radiotherapy the cure of inoperable cancers cannot be obtained.

Postoperative recurrences frequently respond to irradiation and sometimes remain "cured" for long periods, so that prophylactic raying after operation is generally indicated. However, Neher found more recurrences in those breast cases that had been rayed than in those that were not so treated.

As to roentgen therapy of sarcoma, he accepts Jungling's report to the Congress of German Naturalists reported in *Strahlentherapie*, vol. xii.

Lymphatic sarcomata react well to roentgen therapy as compared to surgery, and should be irradiated. Metastases and extensions are common.

Periosteal sarcoma at the hip-joints, shoulder region and pelvis should receive *x*-ray therapy.

Myelogenous giant-celled sarcomata should be irradiated at the time of operation, and radiotherapy should be tried before resorting to amputation.

Osteosarcomata of the skull have been cured over long periods by roentgen therapy.

Sarcomata of the superior maxilla should be treated surgically.

All inoperable sarcomata should be irradiated, even the gliosarcomata where roentgen therapy has done as much as palliative trephining.

In cases of tumors of the hypophysis, good results have been obtained, and also in tumors which, like them, are on the margin of neoplasms of good or bad nature: that is, the fibrous nasopharangeal tumors. These should not be operated on until deep roentgen therapy has been tried.

The successes which are reported would have seemed unbelievable twenty years ago, and in spite of the bad results, we must, as physicians, render homage to the progress, even though, as operators, we may deplore it.

We must not overlook the dangers of irradiation from the simplest reactions to the incurable roentgen cachexia. These are fortunately becoming fewer and fewer, but are still important. Also we must bear in mind the uncertainty

of results, whether the technique or other things are responsible for them.

Second. Is the task of roentgen therapy solely to give to all parts of the body which harbor cancerous cells a determined dose for these cancerous cells? When we succeed, may we be certain of success? In other words, is there a cancer dose?

Essentially the question resolves itself into one of whether or not the cells of all cancers in all patients in all parts of the body, regardless of histological form, react in the same way to roentgen rays. Seitz and Wintz say: "We ought to refuse to admit a refractory state of sarcoma or carcinoma cells to roentgen rays." Against this we have seen superficial metastases disappear under light irradiation, whereas others in well-nourished patients would not regress though given the lethal irradiation for the skin. The author agrees with Jungling in saying that unfortunately there is no cancer dose, even omitting the cachetic patients. The difference between the radiosensibility of different sarcomata is even greater; for instance, lymphosarcomas respond to a small irradiation, whereas those of the melanotic group are very resistant, and moreover, tumors of the same histological structure frequently react quite differently to the same irradiation.

Work has been done on lower animals, demonstrating that different individuals react differently, and the same is unfortunately true of the various tumor cells. A sort of acquired "radio-immunity" must also be considered. We must take into account every biological condition in every cell, for the question of radiotherapy is not purely a physical problem.

Third. On what point do the *x*-rays exert their action? How may one represent the mechanisms of their action? To what practical deductions will this lead?

We know that *x*-rays act principally on tumor cells to damage them. This has been conclusively demonstrated in the study of sections of the tumor and its surrounding tissues. The nuclei of cells have been attacked during mitosis and without reference to disturbed surrounding blood supply. In other words, *x*-rays in sufficient quantities arrest growth. But this may not be all that takes place.

The selective action on certain types of cells has been conclusively demonstrated. However, if such action was all, we could give *enough* radiation to be sure that the growth would disappear. Unfortunately, they do not disappear with the heaviest doses, but may grow even more rapidly; possibly because the surrounding tissues had been so much damaged that they were unable to resist the tumor invasions. Hence we should try to damage the malignant cell, and not overdose its normal neighbor.

We must not forget the importance of the whole organism as well as the mutual actions of the normal and malignant tissues of the area affected, for possibly the purpose of roentgen therapy is only to increase the natural process of healing.

BAYNE-JONES, S. and VAN DER LINGEN. The Bactericidal Action of Ultraviolet Light. *Johns Hopkins Hosp. Bull.*, Jan., 1923, xxxiv, No. 383, 11–15.

This paper describes methods by which exact determinations may be made of the wave-lengths of light which kill bacteria. The sparks of various metals were used as sources of ultraviolet light, except in a few experiments when it was necessary to take advantage of sunlight because of its greater intensity. In most of the work a quartz spectrograph was used. The absorption spectrum of a bacterial emulsion was correlated with the limits of the bactericidal action of light. The effect of temperature and the influence of hydrogen-ion concentration upon the limits and velocity of the germicidal action of ultraviolet light were determined. From the results of these experiments the following conclusions are drawn:

1. The bactericidal action of light is confined to the ultraviolet region of the spectrum, beginning at $350_{\mu\mu}$, and extending with increasing intensity to the shortest wave-lengths measurable with a quartz spectrograph: $185.6_{\mu\mu}$.

2. These limits coincide with the absorption of ultraviolet light by bacteria.

3. The temperature coefficient for the bactericidal action of light was found to be 1.05 over a range of 10° C., and the constant u in the formula Arrhenius was 934 to 975.

4. An increase in hydrogen-ion concentration of the fluid in which bacteria are suspended during their exposure to ultraviolet light increased the velocity of the bactericidal action. The accelerating effect began at P_H 4.6, the isoelectric point, and was very strong in fluids more acid than this.

5. Neither temperature nor the hydrogen-ion concentration rendered bacteria sensitive to the longer wave-lengths of light.

SHERK, HENRY H. Total Transposition of Viscera. *Surg., Gynec. & Obst.*, July, 1922, xxxv, No. 1.

Aristotle's writings show that he had observed two instances of transposed organs in animals.

Petrius Servius, in 1615, recorded the first human case as occurring in Rome, but Carl Beck states that the first authentic case was reported in the time of Molière, in the person of Marie de Medici, Queen of France.

Kuechenmeister was the first to recognize the condition during life, based on the examination made by percussion and auscultation.

According to Sorge, the first *x*-ray record of this condition was made by Vehemeyer in 1897.

In 1865, Grueber collected 79 cases from the literature, only five of which had been recognized during life.

Kuechenmeister, in 1888, collected 149 cases. By 1895, Pic was able to collect 190 reported cases, and in 1902 Arneil added, including his own, 44 more, 38 of which were recognized during life.

Karashuma, in 1912, catalogued over 200 cases and gave what is presumably the best historical resumé.

A communication from the Mayo clinic states that a hurried search of their records shows 10 cases indexed since 1910. From the same period their registration was approximately 347,000, or 1 case in 34,700, which compares with the writer's cases, found in 35,000 army recruits examined by him.

Transposition may be total or partial. The former is by far the more common. The latter is very infrequent. This is especially true of true congenital dextrocardia, as an isolated condition, of which Schreotter says: "None, not combined with transposition of other viscera, have actually been confirmed by autopsy."

Total transposition of viscera is apparently twice as common in men as it is in women, and when occurring in women it has no effect on their child-bearing ability.

Statistics on which to base the incidence of heredity could not be found in literature, no case having been recorded in which the condition occurred in parent and child. Brimblecombe reports one instance of two cases in the same family, brother and sister. It has been suggested that twin pregnancy may have some relationship to the condition, but the writer has no knowledge of such a causation.

Bryant, John. Visceroptosis: Normal Incidence. *J. Am. M. Assn.*, Oct. 29, 1921, lxxvii, 1400.

The author is reporting large series of statistical studies based on extensive post-mortem observations which ought to be of great interest to every roentgenologist. His charts are based on 1966 observations on 290 unselected post-mortem sections of all ages and both sexes. The original articles should be valuable to every diagnostician. The author's summary is as follows:

1. Visceroptosis is, in general, not progressive with age. This is due to the fact that, although the percentage of ptosis of certain viscera increases with age, this percentage increase is offset by a decreasing frequency with age in respect to other viscera.

2. Visceroptosis affecting one or more organs was present to some extent in 48 per cent of all cases examined, it being extreme in 10.2 per cent of the males and 19.7 per cent of the females.

3. Visceroptosis affecting the liver, right and left kidney, stomach and pylorus, is acquired.

4. Visceroptosis affecting the large intestine is in both sexes largely congenital or developmental. The percentage frequency of ptosis of certain portions of the large intestine does, however, further increase with age in both sexes. The greatest discrepancy between the male and female in regard to the percentage frequency of coloptosis in the adult occurs at the ileocecal valve. Thus, this portion of the colon shows an extreme degree of ptosis in 12.1 per cent of the males of all ages; this contrasts with an extreme degree of ptosis at the ileocecal valve in 39.4 per cent of the females of all ages.

5. No normal standard of frequency of visceroptosis, based on unselected material, exists.

In the absence of such a normal standard, proper evaluation of the degree of deviation reported in any selected roentgenologic or other series of cases is impossible.

A standard of frequency of visceroptosis which may be considered adequate until corrected by future investigators is made available in tabular form in the present article.

Lawrence, R. D. The Effect of *X*-Rays on Enzyme Action. *Arch. Radiol. & Electrotb.*, Jan., 1922, xxvii, 244.

The literature on this topic is scanty and the results contradictory. After careful study by a method which is described in detail in the original article, the author concludes that radiation has no effect on enzyme action as shown by the method he employed, and therefore the effect, if any, is extremely slight and of no practical importance.

Roberts, R. E. A Case of Extreme Dilatation of the Duodenum Due to Chronic Obstruction. *Arch. Radiol. & Electrotb.* Jan., 1922, xxvi, 237.

The author reports a rare case of extreme dilatation of the duodenum in which immediately after the opaque meal the stomach was

found to be normal, the duodenal bulb not being seen. After two hours the stomach was seen to be emptying normally, but that barium which had passsed out was seen to be lying at the bottom of a large C-shaped sac with its lower border low down in the pelvis. Above the barium shadow the sac was seen to be almost filled by fluid capped with gas. The upper free level of this fluid showed as a horizontal line above and to the right of the pylorus. A trace of barium could be seen on the floor of the upper arm of the C. The middle portion of the sac is traversed by delicate circular bands. The lower portion of the sac could be freely moved over the abdomen, especially on the left side; this was more evident in the lying-down position. Six hours and twenty-five minutes after the meal a considerable residue of the barium food was still present in the stomach, together with a large amount of secretion; the sac described above could be made out at this and all subsequent examinations up to forty-eight hours, a very small residue of barium being still visible in the stomach. An *x*-ray diagnosis of dilated duodenum was made. At the duodenojejunal flexure a crescentic band of cicatricial tissue was found, which caused a partial stenosis of the gut at this point. About 2 in. below this there was a hernial orifice in the mesentery of the jejunum, through which almost the whole of the remainder of the small intestine had passed, but there was no evidence of obstruction of the small bowel at any point other than the above.

Scholz, Thomas. A Roentgenological Contribution to the Diagnosis of Spinal Carcinoma in Cases Having an Unrecognized Primary Focus. *New York M. J.*, Nov. 15, 1922, cxvi, 566.

Early diagnosis of spinal metastasis in cases showing no apparent primary focus is very difficult. It may be arrived at by means of a thorough and careful analysis of its only symptom, pain, and a careful observation of the course of the disease with its characteristic remissions. Presence of a round gibbus strongly speaks against spinal tuberculosis. Sciatica in elderly people, especially if bilateral, is suggestive of neoplasm of the lumbar spine. Radiographic examinations may prove to become of great diagnostic help early in the disease. They should be made repeatedly and should be arranged individually according to the clinical aspect of the case. They should not be limited to the part of the spine called for, but should include the entire spine and such other parts of the body as may be suspected of having some bearing upon the diagnosis, especially the skull and upper parts of the femora. The radiographic appearance of the metastatic changes may give a suggestion regarding the true nature of the unknown primary focus. Mechanotherapy seems to be very harmful in cases of spinal metastases and should therefore be made use of with great care in spinal conditions. An early diagnosis in spinal carcinoma may give hope of a cure in cases like the first one reported, where the secondary involvement was solitary and comparatively small, and the primary focus, if recognized, could have been removed surgically. Deep *x*-ray therapy in such cases may save the patient's life.

Pfahler, George E. The Treatment of Skin Cancer by *X*-Rays, Radium and Electrocoagulation. *New York M. J.*, Nov. 15, 1922, cxvi, 553.

The author urges that precancerous lesions such as warts, moles, keratoses, and slowly-healing fissures should be destroyed by electrocoagulation, and in this way a great many cancers can be prevented. Every case of epithelioma should be thoroughly treated and completely eliminated at once. It is unwise to destroy cancer piecemeal. Radium properly applied is the best single agent in the treatment of cancer. In all well-advanced cancers two or more methods can generally be combined to advantage in the complete elimination of the disease. Skill, keen judgment, and careful consideration of the individual patient count for much in this field, as they do in every other branch of medical science.

Thomas, B. A., and Pfahler, G. E. Technique of the Treatment of Carcinoma of the Bladder and Prostate by a Combination of Surgery, Electrocoagulation, Radium Implantation and Roentgen Rays. *Arch. Surg.* Mch., 1922, iv, 451.

A very interesting and attractive method of combination of surgery and radiological treatment of bladder and prostatic malignancies is described. In some cases the application is through a suprapubic cystotomy, and in others through a perineal incision for exposure of the prostate and accurate needling with radium needles. Electrocoagulation was used in a certain number of cases. Employing this combination, or quartet, of therapeutic measures, 26 patients have been treated. It is true that originally, in a few cases, the authors' methods, with the present technique, were comparatively crude in some respects. Until three years ago, when the small needles came into use, they were obliged to plant the radium en masse into the growth or its bed; also, the electrocoagulation of the

growth was not so intensively and thoroughly done; indeed, in some instances, the tumor was destroyed or removed by the electrocautery, prior to the implantation of radium.

Nevertheless, it is a remarkable fact that in this series of cases, although some patients have not been relieved of their symptoms, or their symptoms have returned after a period of improvement or actual freedom, only two are known to be dead, and one has been untraceable, a result that could not have been paralleled by any other form of treatment. The majority of these patients have been treated and observed only during the last three years; therefore, the authors are not justified in drawing conclusions, nor is it their intention to make any particular claims as to end-results. They desire simply to describe the technique evolved from experience and at present employed in this surgically unwelcome and disheartening type of formerly inoperable bladder and prostatic carcinoma, and to say that it is their conviction that the treatment here described and practiced offers more in the way of prolongation of life, if not cure in a few rare instances, than any other method of treatment heretofore employed in this particular deplorable type of malignant disease.

HECKEL, EDWARD B. Non-Surgical Treatment of Malignant Epibulbar Neoplasms. *Arch. Ophth.*, Mch., 1922, li, 141.

The author, in 1915, reported a case of epibulbar sarcoma treated with roentgen rays in 1910 with a technique which resulted in complete cure of the malignancy and the preservation of a perfectly functioning eyeball. The success in this case was, the writer believes, the result of keeping the anterior segment of the eyeball wet during the exposure to the roentgen ray, by the continuous dropping of a normal salt solution over the eyeball. Since then, he has been able to discard the salt solution, due to better and more efficient *x*-ray tubes. The technique employed in the following cases consisted of placing the patient in a recumbent, comfortable position, the face covered with a piece of tin foil perforated with a small hole a little larger than the neoplasm, and so placed that when the patient was directed to look in a certain direction the aperture in the tin foil was directly over the neoplasm. This procedure permits the patient the free use of the eyelids so that he may wink as often as he desires; in this manner the cornea is kept moist and cannot dry.

Case I. Epidermoid carcinoma of right eye treated by Dr. George W. Grier. First application 5 ma. current; 6½ in. parallel spark-gap; anode skin distance 8 in.; no filter; time two and a half minutes. Five days later same treatment repeated; three days later same treatment with three instead of two and a half minutes; four days later same treatment as on the third exposure. After these four treatments the patient was given twenty-one days' rest. At the end of this time there was still a small part of the growth remaining. Fifth exposure twenty-four days after the fourth, this time with 10 in. spark-skin distance, three and a half minutes. Sixth exposure, three days later, the same as the fifth except three minutes. The seventh exposure, two days later, the same as fifth exposure. One month later, lesion was completely healed and remained so.

Case II. Squamous-cell carcinoma, right eyeball. Treatment again by Grier as outlined above, twelve exposures being given during seventy days. Photographs of the patients and microphotographs of the tissue removed at biopsy accompany the article. The author calls attention to the necessity of adding treatment with the actual cautery or electrocautery in certain cases where the neoplasm protrudes through the lid aperture.

REGAUD, CL. The Error of Division and Too Frequent Repetition of Doses in the Radiation Treatment of Cancer. *Paris Med.*, Feb. 4, 1922.

According to this author, the cure of a cancer requires the destruction of all the malignant cells. The time during which the total dose necessary for its destruction can be administered is variable. Often, however, cancers are treated by small doses, frequently repeated, during a long period of time. There are two objections to this division and frequent repetition of doses. On the one hand, the repetition of non-lethal doses of irradiation produces a sort of immunity on the part of the neoplastic tissue. On the other hand, there is brought about a sensitization of the normal tissues. This condition is frequently observed in superficial malignancies on the face. Where this technique has brought the progress of a lesion to a standstill, and on account of ulceration no further radiation can be given, it is important, then, to administer the total treatment of a cancer at one application if one wishes to achieve a complete cure.

BRYANT, JOHN. Visceral Adhesions and Bands: Normal Incidence. *Am. J. M. Sc.*, Jan., 1923, iii, 165.

This paper is a continuation of studies already noticed in these columns, undertaken by Bryant on a large series of unselected post-mortem sections. The following conclusions

are of great interest to diagnosticians, especially roentgenologists.

The transverse colon is more frequently involved by adhesions than any other abdominal viscus. Seven women and eight men out of every ten persons presumably have some involvement of this viscus by congenital or acquired adhesions. Next in order of frequency of involvement come the gall-bladder, duodenum, peritoneum, omentum, ascending colon, hepatic flexure, appendix, liver, and descending colon.

Within a range of variation not usually exceeding 10 per cent, the rate of involvement of a given viscus may be greater in the male or in the female, and this relative rate of involvement with regard to sex may further vary with age.

The rate of involvement by adhesions is for several viscera higher in the fetus than at later ages, as the transverse colon in the male and the terminal ileum in the female.

The rate of involvement by adhesions increases rapidly with progressive age for certain other viscera, as the sigmoid flexure in the male and the adnexa in the female.

The age of forty is critical in both sexes with reference to the average number of viscera involved by adhesions in any given case. After the age of forty, there is a sudden increase of involvement by about 50 per cent in both sexes, the increase being somewhat more marked in the male than in the female.

Complexity is practically a synonym for age with regard to the number of viscera involved in any given adhesive process. This increase in complexity amounts to over 200 per cent after forty years of age.

Variety in the character of the adhesions present also increases with age. A sudden marked increase of nearly 100 per cent occurs in the thirty-forty year decade, or ten years earlier than the onset of the marked increase with regard to the average number of viscera involved, and the onset of the increase in the complexity of the adhesions themselves.

The distinguishing characteristics of congenital or developmental adhesions are simplicity and lack of variety in type.

The distinguishing characteristics of acquired adhesions are complexity and variety in type.

Poos, Fritz. Concerning the Indirect Damaging Effects of Irradiation on the Body through Irradiation of Isolated Organs. *Klin.-therap. Wchnschr.*, Apr. 22, 1922, p. 836.

No evidence has been found for the possibility of influencing the specific function of the hypophysis through *x*-ray irradiation. The infantile development of the genitalia which occurs on *x*-ray irradiation of the hypophysis is not dependent upon hormones and should not be considered analogous to the constitutional infantilism. The genital infantilism is considered as part of the phenomena of a typical general deterioration brought about by generalized indirect action of the rays. In all the irradiated (*x*-rayed) animals, whatever the place chosen for irradiation, the condition of the organs was essentially similar to the condition of organs exposed to the direct action of the rays—a typical deterioration of the organs with increased metabolic rate (changes) in the cells.

Groover, Thomas A. The Relation of Radiology to Cancer Control. *South. M. J.*, Jan. 1923, xvi, 11.

The author regrets the fact that in much of the literature on cancer intended for both lay and professional distribution, radiology is referred to mainly for the purpose of warning against it; and by broad implication, at least, the motives, good faith, and professional competency of the radiologist are impugned. Under the guise of a public health crusade, leaders in medical thought have also given expression to similar sentiments on the public platform and through the columns of the daily press. It is doubtful that the exigencies of the situation, or the facts in the case, justify such dogmatic pronouncements, which do not foster that helpful cooperation essential to the success of such movements.

In mapping out a plan of attack upon cancer, or a potential cancer, we have not always a clear conception of the issue involved, namely, that in most instances it is a question of life or death, and that, if we fail to destroy the cancer utterly and completely, the cancer will inevitably destroy the patient. We do not always properly balance our treatment of the patient and our treatment of the disease. The radiologist has been unduly handicapped by the prevailing idea that under no circumstances must he do anything that would jeopardize the vitality of a healty cell. Until he is allowed some of the latitude in this regard that has been by common consent conferred upon the surgeon, his efforts in combating cancer will fall short of the goal.

The author believes that the time will come when we shall say that this particular case is a case for *x*-ray and that particular case is a case for surgery. It is not logical to use two entirely unrelated methods having the same therapeutic object.

MORTON, REGINALD, and LEE, HARRIE B. Some Results of Deep *X*-Ray Therapy. *Lancet*, Jan. 30, 1923, civ, 117.

The authors state that the time has not yet come for them to analyze their results in deep *x*-ray therapy in malignant disease, although they now have over 600 cases to refer to, for the following reasons: (1) Over 95 per cent of the cases treated have been sent up by surgeons or others with the comment "inoperable" or "inoperable recurrence after operation." Such being the case, the percentage of good results is necessarily small, and any figures based on such results would be misleading. (2) In a large majority of cases treated, general dissemination had already begun, and, although the primary focus has disappeared after treatment, death has quickly ensued from involvement of the liver, mediastinum, etc. Here, again, figures would give quite a wrong impression of the results. (3) In regard to the comparatively few early cases treated, the longest interval since signs of the disease have disappeared is only eighteen months, a period quite inadequate within which to say whether they are to be classed as cures or not.

Nevertheless, the authors, feeling that the medical profession would welcome some information on results to be expected from treatment, cite a few cases, giving full details of treatment and results. The case reports would indicate that the method has now fairly well established itself as a means of dealing with cases when nothing else can be done. The results in all cases make the treatment worth while, and in a few instances border on the miraculous. Whether an early case of surgery should be discarded in favor of *x*-rays, it is as yet too early to say; but in all early cases treated, symptoms and signs have disappeared, and so far there has been no recurrence. When surgery is resorted to, the authors strongly urge the employment of deep *x*-ray therapy either before or after operation—preferably before, as a prophylactic measure against recurrence.

SMITH, MORRIS K. Premature Ossification After Separation of the Lower Radial Epiphysis. *Ann. Surg.*, Apr., 1922, lxxv, 501.

The author reports a case of very great interest because of the clear roentgenographic demonstration of premature ossification of the previously separated epiphysis, resulting in arrested growth. The process in the radius was observable in eight months and complete in one year. Another feature of interest is the accompanying ossification in the ulna epiphysis, although the original injury here was a fractured styloid.

ERSKINE, ARTHUR W. *X*-Ray Treatment of Carcinoma of the Breast. *Illinois M. J.*, Mch., 1922, xli, 209.

The author believes that at the present time from ordinary intensive radiation of breast cancer we can reasonably expect:

1. An increase of at least 25 per cent in the number of patients alive five years after operation.
2. Prevention of breaking down and ulceration of the tumor, with its attendant pain, foul odor, and mental anguish. He has seen only one inoperable case break down under *x*-ray treatment.
3. Destruction of superficial metastases.
4. Prolongation of comfortable life.
5. An easy death from distant metastases or intercurrent disease.

The question as to whether or not an attempt should be made to administer a lethal dose to the whole cancer at one sitting is as yet undecided. It is evident that flooding the chest with such a tremendous amount of radiation at one time will produce such a profound constitutional reaction that we should have to be prepared to accept a definite mortality rate from the treatment alone.

Finally, the *x*-ray therapist must remember that he is dealing with a powerful agent, capable of producing harm as well as good. He must remember that insufficient treatment of cancer cases takes away the only chance these patients have for life. Realizing the deadliness of the disease, he must be willing to submit his patients to considerable discomfort, and he must not fear burns of the skin, or even a few deaths. In order to attain the highest degree of success, and to realize the hopes inspired by recent developments in this art, a certain degree of courage is as essential as a mastery of technical details.

(Surely the view expressed in the last two paragraphs of this abstract is an extreme one. The occurrence of deaths in connection with radiotherapy can only serve to discredit it. Ed.)

BOOK REVIEWS

BRONCHOSCOPY AND ESOPHAGOSCOPY. By Chevalier Jackson, M.D. Octavo of 346 pages with 114 illustrations and 4 color plates. Philadelphia and London, 1922. Cloth, $3.50 net.

As stated in the author's preface, this book is an abstract of his previous work, "Peroral Endoscopy and Laryngeal Surgery," published in 1915.

The former treatise was a large heavy volume of over 700 pages. The new volume is in the form of a manual containing less than half the number of pages. The difficult task of presenting by written word the various purely manual endoscopic procedures has been accomplished in the same brilliant manner in which the distinguished author has so successfully solved the many perplexing and unusual problems of endoscopic surgery.

In the main, the author has confined himself to a clear, concise description of the technical details of endoscopic work, which, in his judgment, based on a wide clinical experience, have proved to be the best methods. Consequently the reader is not confronted with a multiplicity of procedures or confused by a mass of historical data. Yet the pruning has been so skilfully accomplished that nothing vital has been sacrificed, and one may confidently predict that the new work will bear fruit in even greater abundance than the older treatise. It instructs and does not weary, it pilots but does not explore. His love of accuracy of statement has prevented creating superfluities, as has his fear of prolixity prevented important omissions.

In his first chapter, "Instrumentarium," he very properly avoids citing the numerous types of endoscopic tubes that have been devised since the development of endoscopic surgery, and confines himself to a description of the distally lighted tubes which bear his name.

The chapter on "Anatomy of the Larynx, Trachea, Bronchi and Esophagus Endoscopically Considered," has been treated at greater length and in more detail than in the older treatise.

The position of the patient in endoscopic examination is also explained in greater detail, and especially helpful are the new drawings showing the schema of position for endoscopic examination—the normal recumbent, the raised flexed, the raised extended and the faulty position with chest heaved and spine arched.

In that portion of the work dealing with "Symptoms and Physical Signs of Foreign Bodies in the Air and Food Passages," the author has arranged in epitomized, compact and yet detailed form, all the latest results of numerous keen observers and careful clinicians. Especially instructive is the well-arranged summary on "Symptomatology and Diagnosis."

The "Roentgen-ray Study in Foreign Body Cases" has been considerably condensed. Some of the newer roentgenographic signs: viz., expiratory valve-like bronchial obstruction produced by nonradiopaque foreign bodies such as peanut kernels, have been described. One might wish that the author had explained in greater detail the method of bronchial mapping or lung mapping by the bronchoscopic introduction of opaque substances such as powdered subnitrate of bismuth. The results have been well illustrated with photographic copies of *x*-ray plates of actual cases.

The chapter on tracheotomy is a valuable and sorely needed addition to medical literature. It contains the clearest, most condensed description and résumé of the indications for tracheotomy, the technique of the operation and the after-care of the patient, that the reviewer has yet seen.

If one were to summarize the virtues of this new work of Jackson's, he could not do better than to say that it comprises all the elements which, in our undergraduate days, we were taught constituted an ideal sentence, namely: Correctness, Clearness, Force, Ease and Unity.

EDWARD L. PRATT.